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VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY—VOL. XXX.

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ON THE

SCIENTIFIC RESULTS

OF THE

VOYAGE OF H.M.S. CHALLENGER

DURING THE YEARS 1873-76

UNDER THE COMMAND OF

CAPTAIN GEORGE S. NARES, R.N., F.R.S.

AND THE LATE

CAPTAIN FRANK TOURLE THOMSON, R.N.

PREPARED UNDER THE SUPERINTENDENCE OF

THE LATE

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REGIUS PROFESSOR OF NATURAL HISTORY IN THE UNIVERSITY OF EDINBURGH
DIRECTOR OF THE CIVILIAN SCIENTIFIC STAFF ON BOARD

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CONTENTS.

Report on the Asteroidea collected by H.M.S. Challenger during the years 1873–1876.

By W. Percy Sladen, F.L.S., &c.

(*The Manuscript was received in Instalments between* 15*th March* 1886 *and* 21*st January* 1889.)

ERRATA.

Page 27, line 2 from below, *for* "Expedtion" *read* "Expedition."
,, 28, ,, 8 from below, *for* "1°·1 C." *read* "−1°·1 C."
,, 29, ,, 4, *for* "1°·1 C." *read* "−1°·1 C."
,, 75, ,, 8 from below, *for* "magniying" *read* "magnifying."
,, 87, ,, 9 from below, *for* "0°·8 C." *read* "−0°·8 C."; and line 7 from below, *for* "0°·6 C." *read* "−0°·6 C."
,, 110, in table, *for* "49" *read* "85."
,, 124, line 23, *for* "Billeton" *read* "Billiton."
,, 174, ,, 15, *for* "Buono" *read* "Bueno."
,, 209, ,, 12 from below, for "*echinulata*" read "*echinulatus*."
,, 238, ,, 15, for "*pumilis*" read "*pumilus*."
,, 248, ,, 8, *for* "115" *read* "150."
,, 253, ,, 17, delete "manuscript," and delete lines 26 and 27. (For *Luidia chefuensis*, Grube, *see Jahres-Ber. Schles. Gesellsch. f. vaterl. Cultur*, 1876, p. 28.)
,, 254, ,, 7, *for* "Della" *read* "Delle."
,, 261, ,, 23, for "*childreni*" read "*equestris*."
,, 287, ,, 16 from below, add "Pl. XLVIII. figs. 5 and 6."
,, 295, last line, *for* "west" *read* "east."
,, 309, line 16, *for* "western" *read* "eastern."
,, 317, ,, 10 from below, *for* "78°·0" *read* "78°·8."
,, 321, ,, 11 from below, for "*tuberculatus*" read "*tuberculosus*."
,, 326, ,, 3 from below, for "*piercei*" read "*peircei*."
,, 344, ,, 6 from below, *for* "latter" *read* "former."
,, 402, ,, 17, for "*pustulata*" read "*pustulatus*."
,, 411, ,, 3 from below, after "*Mag.*" read "*Nat.*"
,, 448, ,, 3 from below, *for* "R<3 *r*" *read* "R>3 *r*."
,, 551, ,, 5, add "Pl. LXII. fig. 1."
,, 553, lines 2 and 9 from below, and p. 554, line 2, for "*fallax*" read "*purpureus*."
,, 739, line 12, for "*von*" read "*non*."

EDITORIAL NOTE.

The collection of Asteroidea is one of the most important made during the voyage of the Challenger. The late Sir C. Wyville Thomson paid considerable attention to these organisms, and at one time had the intention of describing the new species discovered during the Expedition; with this end in view, indeed, he had a few of the specimens figured and lithographed.

Eventually, however, the whole collections were handed over to Mr. W. Percy Sladen for examination and description. The result of Mr. Sladen's work, extending over many years, is now presented in this magnificent Report, which forms Part LI. and Volume XXX. of the Zoological series of Reports, the text and plates being bound up in separate parts.

Not only on account of the large number of forms, but also on account of their representative character, the Challenger collection is unquestionably the most important contribution to this group of animals that has ever been made.

In the Report, supplementary to the treatment of the Challenger material, a compact account of the whole group has been aimed at. Thus (1) under each family an account of all the genera included therein, whether Challenger or not, has been given, and where necessary the grounds on which the classification has been adopted are discussed; (2) under each genus there is a statement of all the known species which are recognised as belonging to that genus, with an account of their geographical distribution: this presents a compact idea of the composition and distribution of each genus; (3) a complete list of all the known species of

recent Asteroidea, with their geographical and bathymetrical distribution, and a full account of all synonyms and changes of name are given; every known starfish is believed to be included, and the recognition of "good species" and "synonyms" is based on personal observation (except in the case of some American types and a few recently described from the French dredgings).

The Report may be considered a monograph on the group, though of course it need hardly be said that previously described and recognised species are not re-described. An entirely new classification of the Asteroidea has been given—it was very unsatisfactory and quite unworkable previously.

All naturalists who appreciate careful and accurate work will join with me in congratulating Mr. Sladen on the completion of his valuable memoir, which extends to 935 pages, and is illustrated by 118 lithographic plates and a map.

JOHN MURRAY.

CHALLENGER OFFICE, 32 QUEEN STREET,
EDINBURGH, *January* 23, 1889.

THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the ASTEROIDEA collected during the Voyage of H.M.S. Challenger during the Years 1873–76. By W. PERCY SLADEN, F.L.S., F.G.S., &c., Secretary of the Linnean Society.

PREFACE.

THE preparation of the Report on the Asteroidea obtained by the Challenger Expedition was entrusted to me by the late Sir C. Wyville Thomson, and I received the collection in the early part of the year 1881. Dr. John Murray subsequently placed in my hands the starfishes collected during the cruises of the "Lightning," "Porcupine," "Knight Errant," and "Triton;" and an account of these is included in the present Report, which has thus become a statement of all the Asteroidea obtained by British deep-sea dredging Expeditions up to the present date.

In the following pages there are described 33 genera, 2 subgenera, 196 species, and 15 varieties first discovered by the Expeditions above named; and 9 other new genera and 3 subgenera, based on forms previously known or not obtained by these Expeditions, are established.

Summarising each Expedition independently: in the Challenger collection there are 84 genera, 5 subgenera, 268 species, and 13 varieties; of which 34 genera, 4 subgenera, 184 species, and 12 varieties are new (five of the new genera and two subgenera being based on types of which one or more representatives have been previously known).

In the "Porcupine" collections of 1869 and 1870 there are 25 genera, 1 subgenus, 29 species, and 1 variety; of which 7 genera, 1 subgenus, 10 species, and 1 variety are new (two of the genera being based on types of which representatives were previously known).

In the "Lightning" collection are 3 genera and 3 species; of which 1 genus and 1 species are new. (In the case of the "Lightning" and "Porcupine" Expeditions it is

probable that a greater number of starfishes were obtained than are here recorded; those enumerated, however, appear to be all the authenticated examples now preserved.)

In the "Knight Errant" collection are 9 genera, 1 subgenus, 10 species, and 2 varieties; of which 4 genera, 2 species, and 2 varieties are new (two of the new genera being based on types of which representatives were previously known).

In the "Triton" collection are 11 genera, 11 species, and 2 varieties; of which 5 genera, 4 species, and 1 variety are new, and two of the new genera are established on types of which representatives were previously known.

In the latest summary of the Asteroidea, published by M. Perrier[1] in 1878, 454 species are enumerated, representing 52 genera. Three of the genera, however, included by M. Perrier are invalid or synonymous, the abstraction of which reduces the number recognised by him to 49. Representatives of 38 of these genera were obtained by the Challenger; that is to say, representatives of more than three-fourths of the previously known types. The remaining 11 genera are either extremely rare or of very local occurrence. These figures indicate in a striking manner that the collection made by the Challenger affords a fair representation of the general character of the Asterid fauna of the globe, so far as known.

The proportionally large number of new species is not surprising, when it is borne in mind that a considerable portion of the track of the Challenger passed through regions which had hitherto been wholly unexplored, or in which the dredge had never previously been employed.

The long list of Asterids inhabiting abyssal depths brought to light by the Challenger and the other Expeditions herein discussed may be said to have opened a new chapter in the history of the Asteroidea. The summary of these forms, nearly all of which belong to previously unknown types, given in the Tables appended to the Report affords the most striking evidence of the important contribution made by the Challenger to our knowledge of the group. Reference to these Tables will render any words of comment by me unnecessary here.

The archaic characters of a number of the deep-sea forms are highly remarkable, and furnish not only a confirmation of the validity of the classification now adopted for the Asteroidea, but also give an important clue to the systematic position of many of the extinct members of the Class.

The large accession of new forms has greatly extended our knowledge of the morphological plasticity of many types, and has thrown important light on the constitution and relations of groups and families. In all cases the descriptions take cognisance of external and general morphological structure, and are not confined merely to details of specific difference, from the systematist's point of view.

All the systems of classification previously employed by writers on the Asteroidea are, in

[1] *Nouv. Archives Mus. Hist. Nat.*, 2e Série, t. i. p. 73.

my opinion, inadequate and artificial; and I have been led to formulate a classification more in accordance with morphological characters as at present understood. I venture to believe that this will be found more convenient for general workers, as well as more natural.

In dealing with the synonymy of a species I have in each case given all the different name-combinations under which the form has been recognised and the author by whom each was originated, but I have not given a citation of all subsequent writers by whom the terms have been copied or used. By this means brevity has been gained, without sacrificing anything pertinent to the history of the name.

In order to add to the completeness of the work, I have given under each genus a notice of all authentic species belonging thereto, and their geographical distribution. I have also added at the end of the Report a synoptic list of the known species of recent Asteroidea, with particulars of their geographical and bathymetrical distribution, the changes of name to which they have been subjected, and their synonyms, which I hope will increase the utility of the Report. A few species which have been inadvertently omitted in the chorological statement of the genera will be found duly recorded in this list. 137 genera and 810 species are here enumerated.

The urgent need of a critical examination by one person of the large number of types distributed throughout the various Continental collections has long been felt by every worker at the group, as many of the types in question have been very imperfectly known, and, owing to insufficient description, numberless false determinations and a confusing multiplication of synonymous terms have arisen. To eliminate as far as possible this element of perplexity, I have visited the chief Continental museums and have personally studied the rich collections at Christiania, Stockholm, Lund, Copenhagen, Leyden, Paris, Berlin, Kiel, Hamburg, Leipzig, Breslau, and Vienna. I venture to believe that the labour thus expended will place the list now given on a more reliable basis than was previously possible.

I desire to acknowledge gratefully the privileges afforded me in this undertaking, and to express my hearty thanks to the Heads of the various universities and museums, who, without exception, placed the collections under their charge unreservedly at my disposal. To the many eminent naturalists who have given me valuable assistance and information I desire to tender my sincere thanks. Some obligations are acknowledged in the text, and in addition to those I cannot refrain from naming here the late Prof. M. Esmark and Dr. Robert Collett of Christiania; Prof. S. Lovén of Stockholm; Dr. Hjalmar Théel of Upsala; Dr. C. D. E. Roth of Lund; Prof. J. J. S. Steenstrup and Prof. Chr. F. Lütken of Copenhagen; the late Prof. H. Schlegel and Dr. F. A. Jentink of Leyden; Prof. Edmond Perrier and M. J. Poirier of Paris; the late Prof. W. Peters, Prof. Ed. von Martens and Dr. F. Hilgendorff of Berlin; Prof. Karl Möbius of Kiel; Prof. H. A. Pagenstecher and Dr. G. Pfeffer of Hamburg; Prof. R. Leuckart and Prof. J. V. Carus of Leipzig; Prof. Anton Schneider of Breslau; Dr. F. Steindachner and Dr. Emil von

Marenzeller of Vienna. To each and to all I desire to express my hearty appreciation of the courtesy and friendly kindness I received at their hands.

My warmest thanks are also due to Dr. A. C. L. G. Günther, the keeper of the Zoological Department of the British Museum, for the many facilities afforded to me during the progress of my work; and especially to my friend, Prof. F. Jeffrey Bell, whose constant and ever-ready assistance has placed me under an indebtedness greater than I can adequately express in words. In like manner, my cordial thanks are given to my friend, Dr. P. Herbert Carpenter, whose critical advice and wide knowledge of Echinoderm literature have always been at my disposal.

In conclusion, I beg to thank most heartily Dr. John Murray for many acts of kindness and assistance during the progress of my Report, and for the friendly willingness he has always shown to meet my views. My thanks are also due to Mr. Wm. E. Hoyle for the attention and trouble he bestowed on my proof-sheets whilst on the Editorial Staff; and to Mr. James Chumley for similar good offices.

To the memory of the late Sir Wyville Thomson, under whose direction this work was commenced, I would pay the tribute of sincere and personal esteem, repeating—not inaptly as it seems to me—the words used by the Danish naturalist, Abildgaard, in writing of his friend, the first great dredger, Otho Frederick Müller, "Loquuntur Eius scripta cum mundo peritura."

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I. *History of the Classification of the Asteroidea.*

The earliest attempt to classify the Asteroidea was made by Linck[1] in 1733, who published the first monograph devoted to starfishes, entitled: De Stellis marinis liber singularis. It is a work worthy of honour, and one which I hold in reverential estimation. Linck divided the "*Stellæ marinæ*" into two sections, named "*Stellæ fissæ*" and "*Stellæ integræ*"—the former characterised by the presence of an open channel or ambulacral furrow along the actinal surface of each of the lobes or rays of the body, the latter by the absence of these open channels. The *Stellæ fissæ* correspond to the Asteroidea of the present nomenclature; the *Stellæ integræ* comprise the Ophiuroidea and the Comatulæ. Linck divided the *Stellæ fissæ*, or section equivalent to the Asteroidea, into three classes, which were based on the number of the rays; the first class embraced forms with less than five rays (all, by the way, abnormal or monstrous forms), the second forms with five rays, and the third all those with more than five rays. The classes were subdivided into genera, those included in the first and third being distinguished by the number of their rays. In the second class, however, the genera were characterised by the general form. This class contained seven genera, four of which are still maintained, viz., *Pentagonaster*, *Pentaceros*, *Astropecten*, and *Palmipes*.

It will be seen from the above that the basis of Linck's classification is purely artificial, the number of rays being the determinating factor.

In 1766 Linné,[2] in the 12th edition of his Systema Naturæ, grouped all the Asteroidea, Ophiuroidea, and Comatulæ known to him in one genus, *Asterias*, which he

[1] De Stellis marinis liber singularis, Lipsiæ, 1733.

[2] Systema Naturæ, Editio Duodecima, Reformata, Holmiæ, 1766.

divided into three sections, named *Integra*, *Stellatæ*, and *Radiatæ*. The representative of the first of these sections cannot now be recognised; the second section is equivalent to the Asteroidea, and comprised nine species; the third section embraced the Ophiuroidea and Comatulæ.

Lamarck,[1] in 1816, divided the *Asterias* of Linné (which he regarded as a family under the name of "Les Stellerides") into four genera, which he named *Comatula*, *Euryale*, *Ophiura*, and *Asterias*, the last being equivalent to the section "*Stellatæ*" of Linné, and to the Asteroidea of the present day. He divided the genus *Asterias* into two sections: (i.) "Asteries scutellées," and (ii.) "Asteries rayonnées," the former embracing the species in which the length of the ray does not exceed that of the diameter of the disk, and the latter those in which the length of the ray is greater than the diameter of the disk.

In 1830 de Blainville[2] proposed to divide the Asteroidea (which he ranked as a family, "Asteridea") into five sections ("genres ou sous-genres"), which were characterised by the general form, and by the number of the rays. The composition of the different groups was more or less heterogeneous, and none of them have been maintained.

In 1834 Nardo[3] grouped a number of species known to him into five genera, two of which are maintained, viz., *Asterina* and *Linckia*.

In 1835 Agassiz[4] divided the *Asterias* of Lamarck (which he ranked as a family in the order "Les Stellerides") into nine genera, including fossil forms. Of the eight genera in which recent forms were included, two are maintained *in statu quo* (*Ophidiaster* and *Culcita*), and the name of a third (*Goniaster*) is used in a restricted sense. The remaining genera correspond to groups named by Linck or Nardo.

This partition of genera was based on a number of structural characters, and was the first approach towards a morphological classification of the group.

In April 1840 Müller and Troschel[5] published a preliminary classification of the Asteroidea, which they divided into three unnamed families, characterised by the presence or absence of an anal aperture, and by the quadriserial or biserial arrangement of the ambulacral tube-feet. Fourteen genera were defined by means of structural characters, and representative species were cited. Two years later this work was expanded into a complete monograph on the group, entitled: System der Asteriden (Braunschweig, 1842), which has formed the basis of all subsequent systematic work on the Asteroidea. In the monograph the three families above indicated comprised eighteen genera, which included 140 species.

[1] Hist. Nat. Anim. s. vert., t. ii. p. 530, 1816.

[2] Dict. Sci. Nat., art. "Zoophyte," t. lx. p. 216, 1830; Manuel d'Actinologie ou de Zoophytologie, 1834, p. 235.

[3] De Asteriis, Oken's Isis, 1834, Heft vii. p. 716.

[4] Prodrome d'une Monographie des Radiaires ou Echinodermes, *Mém. Soc. Sci. Nat. Neuchatel*, t. i. 1835, p. 190.

[5] *Monatsber. d. k. preuss. Akad. d. Wiss. Berlin*, April 1840, p. 102.

In November and December 1840, and consequently only a few months later than Müller and Troschel's preliminary paper above referred to, Gray[1] published a synopsis of the genera and species of starfish. He divided the Asteroidea into two unnamed sections, one characterised by having four rows of ambulacral tube-feet, the other having two rows. The first section contained one family, named "Asteriadæ;" the second section three families, named Astropectinidæ, Pentacerotidæ, and Asterinidæ. These four families comprised forty-five genera and nine subgenera, which were briefly defined by structural characters. This classification was republished as a separate work[2] in 1866, with a few alterations and eight additional genera which had been described in the interim.

In 1869 Perrier[3] published a valuable memoir on the pedicellariæ of Asterids and Echinids.

In 1875 Perrier[4] pointed out that the characters upon which the sectional divisions or families made by Müller and Troschel and by Gray were based were insufficient and unsatisfactory. He insisted upon the importance of the pedicellariæ as a classificatory factor, and he divided the group into two unnamed divisions by means of the character of the pedicellariæ and of the disposition of the ambulacral tube-feet. The first division was characterised by the presence of pedunculate forficiform or forcipiform pedicellariæ, and a usually quadriserial arrangement of the ambulacral tube-feet; the second division by sessile, pincer-formed, or valvate pedicellariæ, and a usually biserial arrangement of the ambulacral tube-feet. The first division contained only one family, the "Asteriadæ;" the second division six families, the Echinasteridæ, the "Linckiadæ," the Goniasteridæ, the Asterinidæ, the Astropectinidæ, and the Pterasteridæ. These seven families embraced forty-five genera (forty-two recognised in the text), a number of Gray's genera being absorbed or altered. Both families and genera were characterised by the structure of the skeleton. This work contains a careful revision of the species contained in the Museum d'Histoire Naturelle of Paris, and supplemented by those in the British Museum.

In 1878 Viguier[5] published an elaborate investigation on the Asterid skeleton, and propounded his discovery that in the mouth-ring of some starfishes the ambulacral plates were predominant, whereas in others the adambulacral plates were predominant. He also showed that a great range of variation occurred in the form of a plate which he called the "odontophore" (the basal interbrachial plate), as well as in the character of the mouth-plates, which he called teeth.

[1] A Synopsis of the Genera and Species of the Class Hypostoma (*Asterias*, Linnæus), *Ann. and Mag. Nat. Hist.*, 1840, vol. vi. p. 175.

[2] Synopsis of the Species of Starfish in the British Museum, London, 1866.

[3] Recherches sur les Pédicellaires et les Ambulacres des Astéries et des Oursins, *Ann. Sci. Nat.*, 5e Série, t. xii. 1869, p. 197.

[4] Révision de la Collection de Stellérides du Muséum d'Histoire Naturelle de Paris (*Archives de Zool. expér.*, t. iv. 1875, pp. 265–450; t. v. 1876, pp. 1–104, 209–304).

[5] Anatomie comparée du Squelette des Stellérides (*Archives de Zool. expér.*, t. vii. 1878, pp. 33–250, pls. v.–xvi.)

On the basis of these researches Viguier proposed an amended classification of the Asteroidea. He divided the class into two sub-classes, named "Astéries ambulacraires" and "Astéries adambulacraires." The first characterised by the predominance of the ambulacral plates in the mouth-ring, the presence of pedunculate forficiform or forcipiform pedicellariæ, and the usually quadriserial arrangement of the ambulacral tube-feet; the second sub-class characterised by the predominance of the adambulacral plates in the mouth-ring, by the presence of sessile, pincer-like, or valvulate pedicellariæ, and by the almost constant biserial arrangement of the ambulacral tube-feet. The first sub-class was divided into three families, the "Asteriadæ," Heliasteridæ, and Brisingidæ. The second sub-class was divided into seven families, the Echinasteridæ, "Linckiadæ," Goniasteridæ, Asterinidæ, Pterasteridæ, Astropectinidæ, and Archasteridæ.

The three families, Heliasteridæ, Brisingidæ, and Archasteridæ are additions to those given in Perrier's list. Perrier, however, included the family Brisingidæ in his remarks, but did not include it in his synoptical table. The genera recognised by Perrier are accepted by Viguier, *Metrodira*, *Nepanthia*, and *Brisinga* being the only additions on his list. Viguier, however, defined the genera chiefly on the basis of his own investigations on the skeleton, the characters of the odontophore and the mouth-plates being used by him as important factors in the classification. On these grounds several of the genera are placed by Viguier in different families and associations from those to which they were referred by Perrier.

In 1879 Zittel[1] published a classification having special reference to fossil forms. He divided the class Asteroidea into two orders—(1) the Ophiuridæ, which was again divided into two sub-orders, the Euryaleæ and the Ophioureæ; and (2) the Stelleridæ, which was subdivided into two sub-orders, the Encrinasteriæ and the Asteriæ veræ. The latter group—which comprises all the recent forms—was simply divided into two unnamed sections, characterised by the quadriserial and the biserial arrangement of the ambulacral tube-feet.

In 1884 Perrier[2] again discussed the question of classification, and pointed out that the structure of the mouth determined by Viguier, and the character of the ambulacral furrow, are morphologically correlated, the one dependent on the other, and that the modifications in the form of the pedicellariæ stand in no definite connection with the structure of the ambulacral furrow and the mouth. From this he was led to discuss the relative taxonomic values of the structure of the ambulacral furrow and mouth on the one hand, and of the form of the pedicellariæ on the other. He decided in favour of the pedicellariæ, on the ground that they are in his opinion aborted rudiments of ancestral organs

[1] Handbuch der Palæontologie, München, 1879, Band i. p. 437.

[2] Mémoire sur les Étoiles de mer recueillies dans la mer des Antilles et le Golfe de Mexique durant les expéditions de dragage faites sous la direction de M. Alexandre Agassiz (*Nouv. Archives Mus. Hist. Nat.*, 2e Série, t. vi. (1884) p. 134).

which were originally more important than at present. As the outcome of these considerations, Perrier relinquished the division of the Asteroidea into two sections or subdivisions, and divided the class into four orders, which he considers may be characterised by the form of the pedicellariæ.

The following is Perrier's[1] summary of his classification, given verbatim :—

1. FORCIPULATÆ.

Pédicellaires pédonculés, droits ou croisés.

Familles: Brisingidæ, Pedicellasteridæ, Asteriadæ, Heliasteridæ.

2. SPINULOSÆ.

Pédicellaires en pince, résultant d'une modification des piquants.

Familles: Echinasteridæ, Pterasteridæ, Asterinidæ.

3. VALVATÆ.

Pédicellaires valvulaires ou en salière.

Familles: Linckiadæ, Goniasteridæ, Asteropsidæ.

4. PAXILLOSÆ.

Pédicellaires formés par un ossicule squelettique et les piquants qui le recouvrent.

Familles: Archasteridæ, Astropectinidæ.

On subsequent pages of the same memoir the names "Spinulosæ" and "Valvatæ" are changed to "Echinulatæ"[2] and "Valvulatæ"[3] respectively, and the following additions are made to the families mentioned :—In the order Spinulosæ, the families "Mithrodinæ" and Solasteridæ are included,[4] and in the order Valvatæ (or Valvulatæ) the families "Gymnasteriadæ," Pentacerotidæ, Antheneidæ, and Pentagonasteridæ take the place[5] of the Goniasteridæ and Asteropsidæ of the above list. Three pages further on another family, Goniopectinidæ,[6] is also referred to this order, Valvulatæ; but in the descriptive part of the memoir, the type (and only) genus, *Goniopecten*, is placed[7] under the family Archasteridæ in the order Paxillosæ.

[1] *Op. cit.*, p. 154.
[2] *Op. cit.*, pp. 167, 206.
[3] *Op. cit.*, pp. 164, 167, 221.
[4] *Op. cit.*, p. 164.
[5] *Op. cit.*, p. 165.
[6] *Op. cit.*, p. 168.
[7] *Op. cit.*, p. 249.

II. *Reasons for considering previous Classifications invalid.*

As the foregoing is the latest scheme of classification, and is, in fact, the embodiment of all that have gone before, I propose to examine briefly the fundamental characters upon which it is based.

Perrier's classification is based upon the character of the pedicellariæ. He considers that the pedicellariæ furnish characters of the highest taxonomic value; in other words, he regards them as class characters, upon the modifications of which divisions of ordinal rank may be made. He assigns to the pedicellariæ this importance on the ground that they are the degenerated rudiments of organs whose functions were more important in the ancestral forms than those which pedicellariæ now perform. Perrier states that the pedicellariæ appear earlier in the embryo of Echinids than the spines. He regards them as more ancient organs. He rejects the view that they are modified forms of spines, as suggested by A. Agassiz. He considers that they furnish positive ordinal characters in the Echinoidea. He asserts that these statements are even more clearly applicable to the Asteroidea than to the Echinoidea. He regards the more complex forms of pedicellariæ as older than the simpler forms, and believes that the forcipiform pedicellariæ are older and more typical than the more simple forficiform pedicellariæ.

Confining my remarks to the Asteroidea, I venture to think that facts do not support any one of these statements, so far as that class is concerned.

(1.) Respecting the priority of appearance in the pedicellariæ and spines, I may say that in no starfish embryo which I have examined have I found anything to warrant the assumption that pedicellariæ appear before spines; in fact, my observations indicate unequivocally that the spines are formed before the pedicellariæ. In *Asterias*, a form which is crowded with pedicellariæ when adult, and is one grouped by Perrier amongst what he considers (erroneously in my opinion) the oldest forms of Asteroidea, this is certainly the case. Neither has any other observer who has written upon the development of starfishes recorded, so far as I am aware, the appearance of pedicellariæ before spines.

(2.) As to whether pedicellariæ are modified forms of spinelets, and as to whether the older forms of the organ are simpler or more complex than the more recent, I consider that those Asterids, which I believe to represent the most archaic forms, distinctly support the views, (i.) that the pedicellariæ are modified spinelets, and (ii.) that the older forms of the organ were simpler and less complex than the more recent. As to the mode in which the more complex forms may have been evolved it is unnecessary to speculate here. The further outcome of the argument that the most complex form of pedicellariæ indicates the most ancient organism would logically lead to the conclusion—although such an opinion is not definitely expressed by Perrier—that the Echinoidea are phylogenetically older than the Asteroidea, for I imagine that it will be generally admitted that the pedicellariæ of Echinoidea are more complex than those of Asteroidea. Such a conclusion, I venture to

believe, would not meet with general acceptance on other grounds, as the Asteroidea are by many considered to represent a more archaic type than the Echinoidea.

(3.) As to whether the pedicellariæ furnish characters by which the four "orders" indicated by Perrier may be distinguished, I consider that they are insufficient and unsatisfactory; and I would venture to say that in my opinion two of the orders in question would be more correctly described as defined by the character of their spinulation. I refer to the Spinulosæ and the Paxillosæ. In his diagnosis of the order Spinulosæ (Echinulatæ), Perrier distinctly states that the pedicellariæ are simply formed of modified spinelets (*op. cit.*, p. 206), and in that of the order Paxillosæ (*op. cit.*, p. 249) no mention whatever is made of pedicellariæ; in the abridged synopsis of the orders, however, given above, the Paxillosæ are defined as characterised by pedicellariæ, formed of an ossicle of the skeleton and the spinelets which cover it (*op. cit.*, p. 154). The statements in the case of these two "orders" would seem to negative Perrier's argument that pedicellariæ are not modified spinelets and that they have nothing to do with those appendages. Furthermore, I fail to see that the characters invoked from the modifications in the form of the pedicellariæ are of sufficient importance to indicate differences of an ordinal degree.

Apart from the above considerations, which negative the view that the pedicellariæ in the Asteroidea afford characters by which orders may be distinguished, I make bold to say that I am unable to regard either pedicellariæ, or spines, or any other mere tegumentary appendages as furnishing characters of sufficient importance to warrant their employment as taxonomic factors of ordinal rank. Though I admit that pedicellariæ do possess characters of a certain taxonomic value, I cannot regard them as characters either of primary or even of secondary importance in the great question of the division of a class.

I may remark in passing that I do not consider the plate to which Viguier has unfortunately given the inappropriate name of "odontophore" to merit the importance which he has placed upon it. The plate in question, which is the basal plate of the interbrachial system, is pushed by development upon the first pair of adambulacral plates, or mouth-plates, and is moulded into form to a certain extent by these plates, its shape being largely dependent on the number of the rays and the character of the adambulacral plates. So far, however, as my own observations go, I am inclined to think that in not a few cases greater differences may be found to exist between the "odontophores," or, as I should prefer to call them, "basal interbrachials," of congeneric species, than between those of species of distinctly separate genera. The form of the plate appears to be extremely variable, and not to present characters of very great taxonomic value.

III. *A Classification of the Asteroidea based on Factors of Morphological Importance.*

Passing in review the various morphological features or fundamental points of structure which are common to the whole class, the following appear to me to present char-

acters whose differences indicate changes in structural detail resulting from modification and development, and show a relationship of subordination which warrant their being ranked as ordinal factors :—

1. The adaptation of the organism to subserve the functions of respiration and excretion.
2. The character of the ambulacral skeleton.
3. The character of the ambital skeleton.

I will remark briefly on each of these topics, confining, however, my observations on the present occasion to the sub-class Euasteroidea, as the other constituents of the Asteroidea are fossil forms whose classification it is not my intention to discuss in this place.

1. The organs which Stimpson[1] first named "papulæ" (abactinal or dorsal water-tubes, A. Agassiz; Hautkiemen, Ludwig; respiratory processes, Carpenter; Kiemenbläschen, Hamann; tubules, Vogt and Yung; branchies lymphatiques, Cuénot; dermal branchiæ, Durham), which puncture the body-wall in the form of delicate transparent membranous cœca, permit an exchange by osmosis of fresh oxygenated fluid from without, and of the effete or carbonised fluid from within the body-cavity. According to Mr. Durham,[2] they would also seem to permit of the passage of "scavenging amœboid cells" and more or less solid particles. The papulæ may be distributed over the whole body, or may be confined to a limited area. By means of their mode of occurrence, the Euasteroidea may be divided into two groups: in one the papulæ are confined to the abactinal surface, and never pass beyond the boundary of the supero-marginal plates, and consequently do not occur in the lateral walls or on the actinal surface; in the other group the papulæ extend beyond the boundary of the supero-marginal plates, and occur in the lateral walls and on the actinal surface. The former of these groups may be called the Stenopneusia, the latter the Adetopneusia. I regard the first group (the Stenopneusia) as the older, and as indicating a simpler or less complex stage of organisation for the performance of the functions in question. Embryology supports this view, for at an early stage in the life history of an Adetopneusate Asterid no papulæ are present; those first formed are confined to the abactinal surface, and the earliest to appear are situated near the base of the ray. It is only at a later stage of growth that the papulæ invade the lateral walls and the actinal surface. In other words, the members of the more highly developed group (the Adetopneusia) pass in the course of their development through a stage which represents the characters of the adult condition of the more primitive group (the Stenopneusia).

2. The ambulacral skeleton—by which I understand not only the ambulacral plates and their associated adambulacral plates, but also the correlated series of tube-feet—exhibits,

[1] *Proc. Boston Soc. Nat. Hist.*, vol. viii. (1862), p. 261.
[2] *Proc. Roy. Soc.* 1888, vol. xliii. p. 329.

when the sub-class is viewed as a whole, two modes of growth; in the one the production of parts is accelerated in relation to the growth of the starfish, in the other the production of parts is retarded, or proceeds *pari passu* with the general development of the skeleton.

In the first group, the production of the ambulacral elements is so rapid and prolific in relation to the development of the starfish and the length of the ray, that the plates become crowded and crushed together, and their individual development, though not essentially reduced, is greatest in a plane at right angles to the axis of the ray, the plates being very short in the longitudinal direction of the ray, and crushed together in consequence of the action of growth-pressure. The segments may become so numerous, and the growth-pressure so great, that the normally single series of ambulacral tube-feet on each side of the median line may be crushed into a zigzag or alternating double series of tube-feet, thus producing a quadriserial arrangement of the tube-feet in each furrow. This character is secondary, however, in my opinion, and results from the degree to which the crushing is carried. I do not therefore consider the quadriserial disposition of the tube-feet to be of sufficient importance to define the primary divisions of a class as previous systematists have done. A further result of this growth-movement and crushing of parts in the ambulacral skeleton is found in the form and posture of the adambulacral plates, which assume a more or less crowded character, and their position becomes transverse. A secondary effect of this action on the adambulacral plates is the influence on the form of the mouth-plates, which is especially conspicuous in the actinostomial ring, the ambulacral elements being rendered the most prominent and define the mouth character, whilst the adambulacral elements are retarded, and have a relatively insignificant character. In consequence of the mode of its formation, I consider the form of the mouth a secondary character. I do not consider it to be of such importance as Viguier does, for although it is true that all Asterids in which the ambulacral skeleton is of the retarded type, or with its growth concurrent with the general development, have an adambulacral mouth, the occurrence of the ambulacral mouth is simply dependent on the degree to which the growth-pressure is extended, as well as the influence of other factors which determine the form of the adambulacral plates.

In the second group, in which the production of parts in the ambulacral skeleton is retarded, or proceeds *pari passu* with the general development of the skeleton, there is little or no action of growth-pressure, the ambulacral and adambulacral plates are not diminished in the longitudinal direction of the ray by crushing, the ambulacral tube-feet are biserial in arrangement, and the adambulacral plates are most prominent in the actinostomial ring, and define the character of the mouth. These two groups may be called the Leptostroteria and the Eurystroteria respectively. I consider the last mentioned of these two groups (the Eurystroteria) to be the older. Embryology supports this view, for at an early stage of a Leptostroterate Asterid (in which when adult the ambulacral tube-feet are quadriserial and the mouth ambulacral), the ambulacral skeleton shows no effects of growth-

pressure, the plates are long in the longitudinal direction of the ray, the ambulacral tube-feet are in regular biserial arrangement, and the mouth is defined by adambulacral plates; it is not until a later stage that the plates become crowded by growth-pressure, that the ambulacral tube-feet are crushed into zigzag or alternating series, forming a quadriserial arrangement, and the mouth-ring is defined by the prominence of the ambulacral plates. It will thus be seen that the members of the more highly developed group (the Leptostroteria) pass in the course of their development through a stage which represents the character of the adult condition of the more primitive group (the Eurystroteria). It is of interest to note that this occurrence and action of growth-pressure in the ambulacral region of Asterids strikingly recalls the growth-pressure shown by Lovén[1] and by Duncan[2] to occur in the ambulacra of the polygeminate forms of regular Echini.

3. The ambital skeleton is formed by the marginal plates and their supplementaries when present. I consider them to be one of the most important systems of plates in the body as determining form and superficial character. Two distinct modes of growth may be defined in the marginal plates of the Euasteroidea, by which the sub-class may be divided into two groups. In the first the marginal plates develop rapidly, and continue to increase in size throughout the life of the starfish, being usually in the adult state the most conspicuous series of plates present, and forming a prominent and massive marginal border. In the second group the marginal plates do not increase in size, or only to an insignificant extent; in fact, their relative size in relation to the body is conspicuously diminished in the adult stage as compared with their proportions in the young stage. They are in consequence often quite inconspicuous in the adult starfish, and can only be discovered by means of dissection, and even then frequently with difficulty. The first of these modes of growth is characterised by the increscent or accelerated development of the marginal plates, and the second by the decrescent or retarded growth of the marginal plates. The former group I call Phanerozonia, in consequence of the prominent and conspicuous character of the marginal plates; the latter group Cryptozonia, in consequence of the insignificant and often hidden character of the marginal plates. I consider that the Phanerozonate group is older than the Cryptozonate, and that the latter indicates a divergence in character and a modification in form correlated with the development of other organic systems. Embryology supports this view of the relative age of the two groups, as in the early stages of the life history of a Cryptozonate Asterid, the marginal plates are large and conspicuous, forming a prominent phanerozonoid margin; it is not until a later stage that the growth of the marginal plates is retarded, and that with the increase in size in the other plates of the test they then appear to be relatively decrescent,

[1] Etudes sur les Echinoïdées. *K. Svensk. Vet.-Akad. Handl.*, Bd. xi. No. 7, pp. 23 *et seq.*, 1874.

[2] On the Anatomy of the Ambulacra of Recent Diadematidæ, *Journ. Linn. Soc. Lond.* (Zool.), vol. xix. p. 95; On the Structure of the Ambulacra of some Fossil Genera and Species of Regular Echinoidea, *Quart. Journ. Geol. Soc. Lond.*, 1885, vol. xli., p. 419.

and at the adult stage have become more or less insignificant. It may hence be stated briefly that the members of the more highly developed group (the Cryptozonia) pass in the course of their development through a stage which represents the characters of the adult condition of the more primitive group (the Phanerozonia).

Of the development of intermediate plates between the supero-marginal and infero-marginal series, and of the relative posture of the plates in these two series in the Cryptozonate Asterids, it is unnecessary here to remark.

From the foregoing considerations it will be seen that three of the most important class characters of the Asteroidea exhibit two modes of presentment, and that by means of any one of the three the Euasteroidea may be divided into two groups, one of which in each case is apparently older than the other.

Now the divisions thus made are essentially equivalent in each of the three categories; that is to say, the older group as determined by one of the characters corresponds to the older group determined by the other two, and similarly with the newer and more highly developed group. The corresponding divisions in each of the three categories are not, however, exactly coequal when regarded independently, nor is this to be expected; but the slight overlap or extension of one or other of the characters in the case of transitional groups is comparatively insignificant: in fact, the result is a "dove-tailing" or interlocking of the groups, which is perfectly natural and in accordance with what is found to occur in other branches of the animal kingdom. We have thus a natural morphological division of the sub-class into two sections or groups on the basis of three independent and important structural factors, one group being more archaic or more primitive than the other. These groups I regard as true natural orders in the strictest sense of the term. To the first or older group I have given the name Phanerozonia, to the second and more highly developed group the name of Cryptozonia.

I have selected the marginal plates for the name character of the orders in consequence of their importance in the Asterid skeleton as well as for the comparative ease with which their character may be observed in the superficial aspect of a starfish.

I shall now proceed to define the families comprised in the two orders, in accordance with my views as to their morphological relations, and shall cite under each the constituent genera. I have been led on structural grounds to establish subfamilies where the divergence of form indicated by the included genera demanded in my opinion this expression of their affinities. In many cases this presentment of the constitution of a group will be found to give a solidarity to the family and an intelligent view of its composition, as well as to indicate the relationships of genera which otherwise would appear isolated and unnaturally placed. As an evolutionist, however, I regard the ideas of species, genera, families, and other divisions, as merely abstract particulars which constitute a synopsis or working key to our views of the affinities of organic forms—the

details in an outline sketch of our attempt to put together the scattered evidences and to trace the lost records of the pedigree of life.

The following is a summary of the classification I have adopted :—

Class ASTEROIDEA.

Sub-class EUASTEROIDEA, Sladen, 1886.[1]

Order I. PHANEROZONIA, Sladen, 1886.

[Stenopneusia : Eurystroteria.]

Euasteroidea with marginal plates large and highly developed in the adult. The supero-marginal and the infero-marginal plates contingent and with their axes usually in parallel planes. Papulæ restricted to the abactinal area, circumscribed by the supero-marginal plates. Ambulacral plates well spaced and usually broad, the development of the ambulacral skeleton being retarded, or concurrent with that of the test generally. Actinostomial ring with the adambulacral plates prominent. Pedicellariæ valvate, foraminate, or excavate.

Family I. Archasteridæ (Viguier, 1878), *emend.* Sladen, 1886.

Phanerozonate Asterids with thick and massive marginal plates bearing spines or spiniform papillæ. Abactinal skeleton with simple spiniform spicules, with pseudo-paxillæ, or with true paxillæ. Actinal interradial areas with plates bearing spinelets. Adambulacral plates large and not compressed. Proctuchous. Pedicellariæ frequently present. No superambulacral plates.

Subfamily 1. Pararchasterinæ, Sladen, 1886.

Archasteridæ with the papulæ confined to a limited area at the base of the ray. Marginal plates more or less alternate. Actinal intermediate plates absent or very few in number.

Genus 1. *Pararchaster*, Sladen.
Genus 2. *Pontaster*, Sladen.

Subfamily 2. Plutonasterinæ, Sladen, 1886.

Archasteridæ with the papulæ distributed over the whole abactinal area. Marginal plates opposite. Actinal intermediate plates well developed. No definite medio-radial line of abactinal plates.

Genus 1. *Dytaster*, Sladen.
Genus 2. *Plutonaster*, Sladen.
Genus 3. *Lonchotaster*, Sladen.

[1] Date when the corresponding sheet of the descriptive portion of this work left my hands for press.

Subfamily 3. PSEUDARCHASTERINÆ, Sladen, 1886.

Archasteridæ with a definite medio-radial line of abactinal plates. Abactinal plates arranged in longitudinal series parallel to the median series. Actinal intermediate plates well developed. Abactinal plates devoid of internal imbricating ridges. No pedicellariæ.

Genus 1. *Pseudarchaster*, Sladen.
Genus 2. *Aphroditaster*, Sladen.

Subfamily 4. ARCHASTERINÆ, Sladen, 1886.

Archasteridæ with a definite medio-radial line of abactinal plates. Abactinal plates in oblique transverse rows on each side of the median series. Abactinal plates with special internal imbricating ridges. Actinal intermediate plates aborted, or very few in number. Pedicellariæ present.

Genus 1. *Archaster* (Müller and Troschel), *emend.* Sladen.

For a Synopsis of the Subfamilies and Genera included in the Family Archasteridæ, see p. 2.

ARCHASTERIDÆ *incertæ sedis.*

The following recently described genera appear to me to belong to the family Archasterinæ, but the descriptions published do not enable me to indicate their position more definitely, and in some cases the reference to the family is doubtful.

Genus *Benthopecten*, Verrill.
Genus *Blakiaster*, Perrier.
Genus *Cheiraster*, Studer.
Genus *Crenaster*, Perrier.
Genus *Goniopecten*, Perrier.
Genus *Pectinaster*, Perrier.
Genus *Luidiaster*, Studer.
? Genus *Odontaster*, Verrill.

Remarks.—Judging from the description alone, I have great hesitation in placing *Odontaster* with the Archasteridæ; it may possibly prove to be more closely allied to the Pentagonasteridæ: in any case it appears to be an annectant genus between the two groups.

Family II. PORCELLANASTERIDÆ, Sladen (1883), *emend.* 1886.

Phanerozonate Asterids with thin and lamelliform marginal plates, naked or covered only with membrane. Abactinal area covered with membrane, beset with simple spini-

ferous spicules or pseudo-paxillæ. A central epiproctal prominence, more or less defined, and frequently developed into an elongate tubular prolongation. Actinal interradial areas more or less extensive, paved with squamiform intermediate plates, covered with delicate membrane. Cribriform organs present. Adambulacral plates large, with a simple marginal armature, uniserially disposed.

Subfamily 1. Porcellanasterinæ, Sladen, 1883.

Porcellanasteridæ with cribriform organs highly developed; localised. Actinal interradial areas with squamiform plates covered with a simple membrane, and not traversed with fimbriated channels.

Genus 1. *Porcellanaster*, Wyville Thomson.
Genus 2. *Styracaster*, Sladen.
Genus 3. *Hyphalaster*, Sladen.
Genus 4. *Thoracaster*, Sladen.
Genus 5. *Pseudaster*, Perrier.

Subfamily 2. Ctenodiscinæ, Sladen, 1886.

Porcellanasteridæ with a simplified form of cribriform organ on the margins of each pair of marginal plates. Actinal interradial areas traversed by fimbriated channels, in continuation of the fasciolar or cribriform channels between the marginal plates.

Genus 1. *Ctenodiscus*, Müller and Troschel.

For a Synopsis of the Subfamilies and Genera included in the Family Porcellanasteridæ, see p. 126.

Family III. Astropectinidæ (Gray, 1840), *emend.*

Phanerozonate Asterids with large marginal plates bearing spines or spiniform papillæ. Abactinal skeleton with true columnar paxillæ. Actinal interradial areas small, intermediate plates when present spinose. Adambulacral plates short and more or less compressed. Superambulacral plates present. Aproctuchous. Pedicellariæ rarely present.

Subfamily 1. Astropectininæ, Sladen, 1887.

Astropectinidæ with adambulacral plates touching the infero-marginal plates along the ray. Marginal and adambulacral plates not correspondent in length and number. Supero-marginal plates more or less well developed.

Genus 1. *Craspidaster*, n. gen.
Genus 2. *Leptoptychaster*, Smith.

Genus 3. *Moiraster*, n. gen.
Genus 4. *Astropecten*, Linck.
Genus 5. *Psilaster*, Sladen.
Genus 6. *Phoxaster*, Sladen.
Genus 7. *Bathybiaster*, Danielssen and Koren.
Genus 8. *Ilyaster*, Danielssen and Koren.

Subfamily 2. Luidiinæ, Sladen, 1887.

Astropectinidæ with the infero-marginal plates separated from the adambulacral plates by a small intermediate plate throughout the ray. Marginal and adambulacral plates correspondent in length and number.

Genus 1. *Luidia*, Forbes.
Genus 2. *Platasterias*, Gray.

For a Synopsis of the Subfamilies and Genera included in the Family Astropectinidæ, see p. 175.

Family IV. Pentagonasteridæ, Perrier, 1884.

Phanerozonate Asterids with thick and massive marginal plates, which may be either naked, or bear granules or spiniform papillæ. Disk largely developed. Apical plates often increscent. Abactinal surface tessellate, with rounded, polygonal, or stellate plates, which may be tabulate or paxilliform. Actinal interradial areas largely developed, covered with pavement-like plates, which may be naked, or covered with membrane, or may bear granules or spinelets.

Subfamily 1. Pentagonasterinæ, Sladen, 1887.

Pentagonasteridæ with the abactinal area paved with rounded, polygonal, or paxilliform plates. Granules or spinelets when present co-ordinated.

Genus 1. *Pentagonaster*, Linck.
Genus 2. *Astrogonium*, Müller and Troschel, *emend.*
Genus 3. *Calliaster*, Gray.
Genus 4. *Chitonaster*, Sladen.
Genus 5. *Calliderma*, Gray.
Genus 6. *Iconaster*, n. gen.
Genus 7. *Gnathaster*, n. gen.
Genus 8. *Nymphaster*, Sladen.
Genus 9. *Paragonaster*, Sladen.
Genus 10. *Mediaster*, Stimpson.
Genus 11. *Nectria*, Gray.

Subfamily 2. Goniodiscinæ, Sladen, 1887.

Pentagonasteridæ with the abactinal area covered with flat stellate plates. Covered with a uniform granulose membrane.

Genus 1. *Stellaster*, Gray.
Genus 2. *Ogmaster*, von Martens.
Genus 3. *Leptogonaster*, Sladen.
Genus 4. *Goniodiscus*, Müller and Troschel, *emend.*

Subfamily 3. Mimasterinæ, Sladen, 1887.

Pentagonasteridæ with the abactinal area covered with small stellate plates bearing true paxillæ. Actinal intermediate areas with imbricating plates in transverse series, bearing paxilliform groups of spines.

Genus 1. *Mimaster*, Sladen.

For a Synopsis of the Subfamilies and Genera included in the Family Pentagonasteridæ, see p. 262.

Pentagonasteridæ *incertæ sedis*.

I am unable to indicate the subfamily in which the first of the two following genera should be placed, in consequence of the contradictory statements respecting the nature of its abactinal skeleton. The description of the second genus, *Hoplaster*, is so brief and insufficient, that its inclusion in this family is for the present purely tentative. If *Hoplaster* should prove to be correctly referred to the Pentagonasteridæ, it would seem probable that it may be ranked in the subfamily Pentagonasterinæ.

Genus *Anthenoides*, Perrier.
Genus *Hoplaster*, Perrier.

Family V. Antheneidæ, Perrier, 1884.

Phanerozonate Asterids with thick and massive marginal plates, which may bear granules or tubercles. Abactinal skeleton stellato-reticulate, or with rounded plates bearing granules and tubercles, and may be covered with membrane. Actinal interradial areas with pavement-like plates, which bear large valvate pedicellariæ.

Genus 1. *Anthenea*, Gray.
Genus 2. *Goniaster* (Agassiz), *emend.* Perrier.
Genus 3. *Hippasteria*, Gray.

Family VI. Pentacerotidæ (Gray), *emend.* Perrier, 1884.

Phanerozonate Asterids with unequally developed marginal plates, the superior series being frequently masked or hidden in membrane. Abactinal skeleton reticulate. Plates with large isolated tubercles or spinelets, or granulose, or covered with membrane. Actinal interradial areas with large pavement-like plates, which bear unequal-sized granules.

Genus 1. *Pentaceros*, Linck.
Genus 2. *Nidorellia*, Gray.
Genus 3. *Amphiaster*, Verrill.
Genus 4. *Pentaceropsis*, n. gen.
Genus 5. *Culcita*, Agassiz.
Genus 6. *Asterodiscus*, Gray.
Genus 7. *Choriaster*, Lütken.
Genus 8. *Paulia*, Gray.

For a Synopsis of the Genera included in the Family Pentacerotidæ, see p. 343.

Family VII. Gymnasteriidæ, Perrier, 1884.

Phanerozonate Asterids with unequally developed marginal plates. Abactinal skeleton tessellate, the plates being often irregular and only partially contingent. The whole test covered with membrane, which may be simple, or granulose, or beset with spinelets. Actinal interradial areas with large regular plates, often in isolated serial arrangement.

Genus 1. *Asteropsis*, Müller and Troschel.
Genus 2. *Dermasterias*, Perrier.
Genus 3. *Gymnasteria*, Gray.
Genus 4. *Tylaster*, Danielssen and Koren.
Genus 5. *Porania*, Gray.
Genus 6. *Marginaster*, Perrier.
Genus 7. *Rhegaster*, Sladen.
Genus 8. *Poraniomorpha*, Danielssen and Koren.
Genus 9. *Lasiaster*, n. gen.

For a Synopsis of the Genera included in the Family Gymnasteriidæ, see p. 355.

Family VIII. Asterinidæ (Gray, 1840), *emend.* Perrier, 1875.

Phanerozonate Asterids with small marginal plates, in some forms inconspicuous and with their axes convergent. Abactinal skeleton composed of imbricating and usually

lamelliform plates, notched on one side and bearing spines on the free margin; or irregular rounded plates with tufts of spinelets. Actinal interradial areas with imbricating plates bearing spines. No pedicellariæ.

Subfamily 1. Ganeriinæ, Sladen, 1888.

Asterinidæ with large marginal plates, and superficially phanerozonoid in character.

Genus 1. *Cycethra*, Bell.
Genus 2. *Ganeria*, Gray.

Subfamily 2. Asterininæ, Sladen, 1888.

Asterinidæ with marginal plates equal to or smaller than the other plates. Papulæ distributed throughout the abactinal area. Abactinal plates thick, crescentiform, devoid of internal processes.

Genus 1. *Patiria* (Gray), *emend.* Perrier.
Genus 2. *Nepanthia*, Gray.
Genus 3. *Asterina*, Nardo.
Genus 4. *Disasterina*, Perrier.

Subfamily 3. Palmipedinæ, Sladen, 1888.

Asterinidæ with the papulæ confined to the radial regions. Abactinal plates in the median regions stellate. Abactinal plates thin, scale-like, with elongate internal prolongations.

Genus 1. *Palmipes*, Linck.
Genus 2. *Stegnaster*, n. gen.

For a Synopsis of the Subfamilies and Genera included in the Family Asterinidæ, see p. 375.

Asterinidæ *incertæ sedis*.

Genus *Tremaster*, Verrill.

The description given of this genus is not sufficient to indicate whether it should be placed amongst the Asterininæ or the Palmipedinæ. It is even possible that its abnormal structure may require the establishment of an independent subfamily which should be called Tremasterinæ.

Order II. CRYPTOZONIA, Sladen, 1888.

[Adetopneusia : Leptostroteria.]

Euasteroidea with marginal plates inconspicuous and more or less rudimentary in the adult. The supero-marginal plates often separated from the infero-marginal plates by

intermediate plates, and their axes are usually not in parallel planes. Papulæ not confined to the area circumscribed by the supero-marginal plates, but often present between the marginal plates and on the actinal surface. Ambulacral plates more or less crowded and narrow, the development of the ambulacral skeleton being frequently greatly accelerated in relation to that of the test generally. Actinostomial ring with ambulacral or adambulacral plates prominent. Pedicellariæ pedunculate or sessile, not foraminate (except in the Linckiidæ).

Family I. Linckiidæ, Perrier, 1875, *emend.*

Cryptozonate Asterids with comparatively well-developed marginal plates, always contingent. Disk small, rays long and cylindrical. Abactinal skeleton tessellate. Tegumentary developments granulate. Superambulacral plates usually present (wanting in *Fromia* and *Ferdina*). Pedicellariæ (rarely present) excavate or foraminate.

Subfamily 1. Chætasterinæ, Sladen, 1888.

Linckiidæ with abactinal plates with internal supplementary plates. Abactinal plates with paxilliform tabula.

Genus 1. *Chætaster*, Müller and Troschel.

Subfamily 2. Linckiinæ, Sladen, 1888.

Linckiidæ with abactinal plates devoid of internal supplementary plates; not forming paxilliform tabula. Abactinal and marginal plates granulose, and not bearing spines.

Genus 1. *Fromia*, Gray.
Genus 2. *Ferdina*, Gray.
Genus 3. *Ophidiaster*, Agassiz.
Genus 4. *Pharia*, Gray.
Genus 5. *Leiaster*, Peters.
Genus 6. *Linckia*, Gray.
Genus 7. *Phataria*, Gray.
Genus 8. *Nardoa*, Gray, *emend.*
Genus 9. *Narcissia*, Gray.

Subfamily 3. Metrodirinæ, Sladen, 1888.

Linckiidæ with abactinal plates devoid of internal supplementary plates; not forming paxilliform tabula. Abactinal and marginal plates covered with membrane, the former and occasionally the latter bearing isolated and skin-covered spinelets.

Genus 1. *Metrodira*, Gray.

For a Synopsis of the Subfamilies and Genera included in the Family Linckiidæ, see p. 397.

Family II. Zoroasteridæ, Sladen, 1888.

Cryptozonate Asterids with contingent marginal plates. Disk small; rays long, cylindrical, and tapering. Abactinal skeleton tessellate, arranged in regular longitudinal and transverse series. Primary apical plates persistent in the adult. Tegumentary developments spiniform (long and needle-like). Adambulacral plates unequal, alternate plates with prominent ridges. Adambulacral armature complex, polyacanthid. Pedicellariæ (forcipulate) pedunculate.

Genus 1. *Zoroaster*, Wyville Thomson.
Genus 2. *Cnemidaster*, n. gen.
Genus 3. *Pholidaster*, Sladen.

Family III. Stichasteridæ, Perrier, 1885.

Cryptozonate Asterids with contingent marginal plates. Abactinal skeleton tessellate, arranged in more or less regular longitudinal series. Tegumentary developments spiniform (equal and papilliform or granuliform). Adambulacral plates small, equal, compressed, with no ridges. Adambulacral armature simple, diplacanthid. Pedicellariæ forcipiform and forficiform.

Genus 1. *Stichaster*, Müller and Troschel.
Genus 2. *Neomorphaster*, n. gen.
Genus 3. *Tarsaster*, n. gen.

Family IV. Solasteridæ, Perrier, 1884.

Cryptozonate Asterids with a reticulate abactinal skeleton, more or less irregular, with plates bearing paxilliform groups of spines. Actinal intermediate plates more or less developed. Armature of the adambulacral plates pectinate, all with a transverse series, some with a second series at right angles to this, parallel to the furrow. With interbrachial septa. No supradermal membrane. No pedicellariæ.

Subfamily 1. Solasterinæ, Sladen, 1888.

Solasteridæ with the armature of the adambulacral plates in two series at right angles to each other.

Genus 1. *Crossaster*, Müller and Troschel.
Genus 2. *Solaster*, Forbes.
Genus 3. *Lophaster*, Verrill.
Genus 4. *Rhipidaster*, n. gen.

Subfamily 2. Korethrasterinæ, Sladen, 1888.

Solasteridæ with the armature of the adambulacral plates forming with that of the actinal intermediate or infero-marginal plates a single transverse series.

Genus 1. *Korethraster*, Wyville Thomson.
Genus 2. *Peribolaster*, Sladen.

For a Synopsis of the Subfamilies and Genera included in the Family Solasteridæ, see p. 442.

Solasteridæ *incertæ sedis*.

Genus *Ctenaster*, Perrier.
Genus *Radiaster*, Perrier.

I have followed M. Perrier in placing these two genera in the Solasteridæ; I am unable to speak of either of the forms from personal knowledge. The descriptions and figures are insufficient.

Family V. Pterasteridæ, Perrier, 1875.

Cryptozonate Asterids with the abactinal skeleton formed of cruciform or stellate plates, bearing paxilliform groups of spinelets. With a nidamental cavity formed by a supradorsal canopy, opening centrally by a valvular structure. In some forms the supradorsal membrane may be partially or wholly aborted. Segmental apertures and papillæ usually present. Actino-lateral spines when present forming a fine web, or merged in the actinal floor. No actinal intermediate plates. No interbrachial septa. No pedicellariæ.

Subfamily 1. Pterasterinæ, Sladen, 1888.

Pterasteridæ furnished with a supradorsal membrane. With actino-lateral spines. With segmental apertures. Form disco-pentagonal, rays slightly produced. Abactinal spinelets long, forming highly developed pedicellated paxillæ.

Genus 1. *Pteraster*, Müller and Troschel.
Genus 2. *Retaster*, Perrier.
Genus 3. *Marsipaster*, Sladen.
Genus 4. *Calyptraster*, Sladen.
Genus 5. *Hymenaster*, Wyville Thomson.
Genus 6. *Benthaster*, Sladen.
Genus 7. *Myxaster*, Perrier.
Genus 8. *Cryptaster*, Perrier.

Subfamily 2. Pythonasterinæ, Sladen, 1888.

Pterasteridæ having a stellate form, with greatly produced attenuate and cylindrical rays. Supradorsal membrane absent. No actino-lateral spines, and no segmental apertures. Abactinal spines short, in sheathed fascicules, not forming pedicellate paxillæ.

Genus 1. *Pythonaster*, Sladen.

For a Synopsis of the Subfamilies and Genera included in the Family Pterasteridæ, see p. 469.

Family VI. Echinasteridæ, Verrill, 1871 (1867), *emend.*

Cryptozonate Asterids with a reticulate abactinal skeleton, often irregular, formed of small imbricating plates, bearing isolated or grouped spines. Disk sometimes large but usually small, with the rays elongate and often subcylindrical. With single interbrachial septa. Actinostomial margin defined by adambulacral plates. Ambulacral tube-feet biserial. Pedicellariæ rarely present (only known in two genera); monomorphic; never forcipiform.

Subfamily 1. Acanthasterinæ, Sladen, 1888.

Echinasteridæ with a large disk and numerous rays. Armed with large isolated spines covered with membrane beset with calcareous granules. Numerous madreporiform bodies. Forficiform pedicellariæ present.

Genus 1. *Acanthaster*, Gervais.

Subfamily 2. Mithrodiinæ, Viguier, 1878.

Echinasteridæ with a small disk and usually five elongate rays. Armed with large spines beset with scales or asperities. One madreporiform body. No pedicellariæ present. No interbrachial partitions.

Genus 1. *Mithrodia*, Gray.

Subfamily 3. Echinasterinæ, Viguier, 1878.

Echinasteridæ with a small or medium-sized disk and five or six rays. Spinulation small and simple; spinelets isolated or grouped. No pedicellariæ present.

Genus 1. *Cribrella* (Agassiz), Forbes.
Genus 2. *Perknaster*, n. gen.
Genus 3. *Echinaster*, Müller and Troschel.
Genus 4. *Plectaster*, n. gen.

Subfamily 4. Valvasterinæ, Viguier, 1878.

Echinasteridæ with moderately developed disk and five rays. Abactinal plates regularly disposed, bearing small isolated spinelets. Marginal plates with large valvate pedicellariæ. Actinal intermediate plates bearing one or more large flattened spinelets.

Genus 1. *Valvaster*, Perrier.

For a Synopsis of the Subfamilies and Genera included in the Family Echinasteridæ, see p. 536.

Family VII. Heliasteridæ, Viguier, 1878.

Cryptozonate Asterids with largely developed disk and very numerous short rays. Abactinal skeleton reticulate, with plates bearing isolated or grouped spinelets, but never composite or paxilliform. With double interbrachial septa. Armature of the adambulacral plates simple, monacanthid.

Genus 1. *Heliaster*, Gray.

Family VIII. Pedicellasteridæ, Perrier, 1884.

Cryptozonate Asterids with a small disk and narrow subcylindrical rays. Abactinal skeleton composed of narrow band-like plates, disposed longitudinally and transversely, forming wide quadrangular meshes. With short isolated spinelets at the decussations. Actinostomial margin defined by adambulacral plates. Ambulacral tube-feet biserial. Numerous large forcipiform pedicellariæ.

Genus 1. *Pedicellaster*, Sars.

Family IX. Asteriidæ, Gray, 1840, *emend.*

Cryptozonate Asterids with an irregular or subregular reticulate abactinal skeleton composed of small unequal plates, which bear isolated or grouped spinelets. Actinostomial margin defined by ambulacral plates. Ambulacral tube-feet quadriserial. Pedicellariæ of two forms, forficiform and forcipiform.

Genus 1. *Asterias*, Linné.
Genus 2. *Uniophora*, Gray.
Genus 3. *Calvasterias*, Perrier.
Genus 4. *Anasterias*, Perrier.
Genus 5. *Pycnopodia*, Stimpson.
? Genus 6. *Coronaster*, Perrier.
? Genus 7. *Astrella*, Perrier.

Remarks.—The genus *Coronaster* is referred by M. Perrier to the Brisingidæ, but I am unable to recognise in the description any characters to warrant that classification. I have therefore ventured to place it with doubt in this family. The description of *Astrella* is so very brief that I am unable to form any definite opinion as to the family to which it should be referred. Its position in the Asteriidæ can therefore only be considered provisional, until a complete description is published. The form described appears to be immature. Some of the characters mentioned by M. Perrier suggest at first the thought that the affinities of *Astrella* might be with the Archasteridæ, but the presence of the transverse ossicles between the adambulacral and marginal plates would seem to negative that view entirely.

For a Synopsis of the Genera included in the Family Asteriidæ, see p. 560.

Family X. Brisingidæ, Sars, 1875.

Cryptozonate Asterids with numerous very elongate rays readily detachable from the disk. Marginal plates in part aborted altogether, elsewhere represented only by microscopic rudiments. Abactinal skeleton aborted or present only on the ovarial regions. Actinal intermediate plates altogether absent. Long lateral spinelets. Spinelets in sheaths crowded with pedicellariæ. No interbrachial septa.

Genus 1. *Labidiaster*, Lütken.
Genus 2. *Odinia*, Perrier.
Genus 3. *Brisinga*, Asbjørnsen.
Genus 4. *Freyella*, Perrier.
Genus 5. *Colpaster*, n. gen.
? Genus 6. *Brisingaster*, de Loriol.
? Genus 7. *Hymenodiscus*, Perrier.
? Genus 8. *Gymnobrisinga*, Studer.

Remarks.—I feel much doubt as to the generic validity of the three last-mentioned genera. I have therefore placed a query before each of them, pending the establishment of their independence as genera distinct from *Brisinga*.

For a Synopsis of the Genera included in the Family Brisingidæ, see p. 589.

The following Synopsis of the principal divisions of the Sub-class will bring the classification of the group into a compact form; it will also be useful in showing negative and antithetical characters not included in the foregoing diagnoses:—

Synopsis of the Orders and Families of the Sub-class EUASTEROIDEA.

I. Marginal plates large and highly developed in the adult. Papulæ restricted to the abactinal area, circumscribed by the supero-marginal plates. Ambulacral plates well spaced and usually broad. Actinostomial ring

with adambulacral plates prominent. Pedicellariæ valvate, foraminate or excavate . . . . . Order PHANEROZONIA.

A. Marginal plates large and conspicuous; with the axes of the plates of the two series usually in parallel planes.

a. Apical plates decrescent. Abactinal skeleton with simple spiniferous spicules, with pseudo-paxillæ, or true columnar paxillæ. Tegumentary developments usually spiniform.

a. Marginal plates thin and lamelliform, naked, or covered only with membrane. Actinal areas paved with thin squamiform plates covered with delicate membrane. Cribriform organs present. Adambulacral plates with a simple marginal armature, uniserial . . . . . PORCELLANASTERIDÆ.

b. Marginal plates thick and massive, covered with spines or papillæ. Actinal areas small, plates when present covered with spines. No cribriform organs. Adambulacral plates with a complex armature, grouped or in several series.

α. Proctuchous. Devoid of superambulacral plates. Adambulacral plates large and not compressed. Pedicellariæ usually present . . . . . ARCHASTERIDÆ.

β. Aproctuchous. With superambulacral plates. Adambulacral plates short, and more or less compressed. Pedicellariæ rarely present . . . . . ASTROPECTINIDÆ.

b. Apical plates often increscent. Abactinal skeleton tessellate. Tegumentary developments usually graniform. Actinal interradial areas well developed.

a. Abactinal skeleton tessellate, the plates often more or less tabulate, with co-ordinated granules simulating paxillæ . PENTAGONASTERIDÆ.

b. Abactinal skeleton stellato-reticulate.

α. Abactinal plates with granules and tubercles. Actinal intermediate plates with large valvate pedicellariæ . ANTHENEIDÆ.

β. Abactinal plates with large conical spiniform tubercles. Actinal intermediate plates devoid of large valvate pedicellariæ . . . . . PENTACEROTIDÆ.

c. Abactinal skeleton tessellate, the plates often irregular and only partially contingent, covered with skin . . . GYMNASTERIIDÆ.

B. Marginal plates comparatively small and inconspicuous; with the axes of the plates of the two series convergent and not in parallel planes. Abactinal skeleton with lamelliform plates, imbricating, notched on one side, with spines on the free margins. Spines on the actinal intermediate plates. No pedicellariæ . . . . ASTERINIDÆ.

II. Marginal plates small and inconspicuous. Papulæ not confined to the area circumscribed by the supero-marginal plates, but often present between the marginal plates and on the actinal surface. Ambulacral plates more or less crowded and narrow. Actinostomial ring with ambulacral or adambulacral plates prominent. Pedicellariæ pedunculate or sessile, not foraminate Order CRYPTOZONIA.

A. Marginal plates small but persistent. Abactinal skeleton more or less fully developed. Parambulacral and actinal intermediate plates present; one or both more or less fully represented. Interbrachial septa usually present.

a. Abactinal skeleton tessellate, arranged in more or less regular longitudinal series. With intra- and infra-marginal papulæ. Primary apical plates persistent in the adult. Marginal plates well developed and always contingent.
  a. Superambulacral plates usually present. Tegumentary developments granulate. Pedicellariæ (rarely present) excavate . . . . . LINCKIIDÆ.
  b. No superambulacral plates. Tegumentary developments spinulate. Pedicellariæ (forcipulate) pedunculate.
    α. Adambulacral plates unequal, alternate plates with prominent ridges. Adambulacral armature complex, polyacanthid. Pedicellariæ (forcipulate) pedunculate . . ZOROASTERIDÆ.
    β. Adambulacral plates small, equal, compressed, with no ridges. Adambulacral armature simple, diplacanthid. Pedicellariæ forcipiform and forficiform . . . STICHASTERIDÆ.
b. Abactinal skeleton reticulate, more or less irregular. With or without intra- and infra-marginal papulæ. Primary apical plates aborted in the adult. Marginal plates feebly developed and often separated by intermediate plates.
  a. With no intra-marginal papulæ. Adambulacral armature pectinate. Abactinal skeleton with a more or less highly developed composite spinulation (subpaxilliform).
    α. With actinal intermediate plates more or less developed. Interbrachial septa present. No supradorsal membrane . . . . . SOLASTERIDÆ.
    β. No actinal intermediate plates. No interbrachial septa. With a supradorsal membrane forming a more or less perfect nidamental cavity . . . . . PTERASTERIDÆ.
  b. With intra-marginal papulæ. Adambulacral armature isolate or grouped, not pectinate. Abactinal skeleton with spinelets isolated or grouped, but never composite or paxilliform.
    α. With double interbrachial septa . . . . . HELIASTERIDÆ.
    β. With single interbrachial septa.
      i. Actinostomial ring with adambulacral plates prominent. Ambulacral tube-feet biserial.
        1. Pedicellariæ rarely present, never forcipiform. Abactinal skeleton forming an irregular meshwork . . . . . ECHINASTERIDÆ.
        2. With forcipiform pedicellariæ. Abactinal skeleton forming a regular quadrangular meshwork . . . . . PEDICELLASTERIDÆ.
      ii. Actinostomial ring with ambulacral plates prominent. Ambulacral tube-feet quadriserial . . ASTERIIDÆ.
B. Marginal plates in part aborted altogether, elsewhere represented only by microscopic rudiments. Abactinal skeleton aborted, or present only on the disk and ovarial regions. Parambulacral and intermediate actinal plates altogether absent. No interbrachial septa. Spinelets in sheaths clothed with pedicellariæ . . . . . BRISINGIDÆ.

DESCRIPTION OF GENERA AND SPECIES.

Class ASTEROIDEA.

Sub-class EUASTEROIDEA, Sladen, 1886.

Order PHANEROZONIA, Sladen, 1886.

Family Archasteridæ (Viguier, 1878), *emend.* Sladen, 1886.

This family was first established by Viguier,[1] and comprised in his estimation the single genus *Archaster* of Müller and Troschel, to which at that date about twelve species were referred. Viguier, however, appears to have only had the opportunity of examining specimens of three or four of these, and the two species, *Archaster typicus*, M. and T., and *Archaster angulatus*, M. and T., were the forms taken by him as typical, and from the study of which the characters of the family were formulated. The genus *Archaster* was first established by Müller and Troschel,[2] for the reception of the two species named by them *Archaster typicus* and *Archaster hesperus*. Other species were subsequently referred to the same genus, though many are so widely different that latterly *Archaster* might well lay claim to be considered as the "refuge for the destitute!" It is scarcely exaggeration to say that most of the long-rayed Phanerozonate Asterids that could not immediately be ranked either as *Pentagonaster* on the one hand or *Astropecten* on the other, were at once set down as *Archaster!* Amongst the Starfishes thus disposed of were several deep-water forms, and a number of those recently discovered were temporarily relegated in like manner to *Archaster* at the time they were taken, and before the species were systematically described. In this way *Archaster*, and consequently the Archasteridæ, have come to be spoken of as characteristic abyssal forms.

I have considered it desirable, for reasons explained in their proper place, to divide the species that have hitherto been called *Archaster* into several genera, and some of these it has been necessary, on account of their structure, to remove from the family Archasteridæ altogether. The establishment of several new genera has likewise been requisite for the reception of new types. Amongst the series of allied genera that constitute in my classification the family Archasteridæ, the genus *Archaster* as now limited is in many respects a very divergent form, and is certainly not the one which I

[1] *Archives de Zool. expér.*, 1878, t. vii. p. 235.

[2] *Monatsber. d. k. Akad. d. Wiss. Berlin*, April 1840, p. 104.

should have chosen as the type of the family. From the fact, however, that the name has already passed into general use, and that a number of the deep-sea forms have been understood, at least conventionally, as belonging to that family, the designation has had a significance given to it beyond the scope of special students of the Asteroidea. Under these circumstances it seems to me better to avoid confusion by retaining the name of Archasteridæ, than to give a new family name based on a genus that would be more generally typical of the group as a whole; though the latter course would have been undoubtedly preferable if the considerations I have mentioned above had not stood in the way.

The following tabular arrangement will show the relations of the genera herein described, which are now classed in the family Archasteridæ; and also the four sub-families into which they are naturally divisible.

Synopsis of Genera included in the Family Archasteridæ.

A. No definite medio-radial line of abactinal plates.
- a. Papulæ confined to a limited area at the base of the ray. Marginal plates more or less alternate. Actinal intermediate plates absent or very few in number . . . . . Pararchasterinæ.
  - *a.* With large odd interradial marginal plate and spine. No true paxillæ. Spicule bearing plates only. No special papular organ . . *Pararchaster.*
  - *b.* No odd interradial plate. True paxillæ. Special papular organ . . *Pontaster.*
- b. Papulæ distributed over the whole abactinal area. Marginal plates opposite. Actinal intermediate plates well developed . . Plutonasterinæ.
  - *a.* Marginal plates more or less equally developed in each series.
    - *α.* Supero-marginal plates thin and plate-formed; confined to the lateral wall; armed with a spine. No order of abactinal plates. Pedicellariæ present . . . *Dytaster.*
    - *β.* Supero-marginal plates thick and massive, extending more or less on abactinal surface; usually unarmed. Abactinal plates along the margin of the ray in more or less definite transverse series. No pedicellariæ . . . . . *Plutonaster.*
  - *b.* Supero-marginal plates almost aborted . . . . . *Lonchotaster.*

B. With a definite medio-radial line of abactinal plates.
- a. Abactinal plates arranged in longitudinal series parallel to the median series. No internal imbricating ridges. Actinal intermediate plates well developed. No pedicellariæ . . . Pseudarchasterinæ.
  - *a.* Adambulacral armature: furrow series radiating, subpalmate; actinal spines in a co-ordinated group . . . . . *Pseudarchaster.*
  - *b.* Adambulacral armature in longitudinal series parallel to the furrow. Post-adambulacral plates with fascioles . . . *Aphroditaster.*
- b. Abactinal plates in oblique transverse rows on each side of the median series. With special internal imbricating ridges. Actinal intermediate plates aborted or very few in number. Pedicellariæ present . . . . . Archasterinæ.
  - *a.* Adambulacral armature Astropectinoid, with oblique median series. Flattened squamiform spinelets on infero-marginal plates . . . . . *Archaster.*

In this family will also be included the genera *Benthopecten* of Verrill,[1] *Cheiraster* of Studer,[2] and, according to their distinguished author, perhaps also *Blakiaster*, Perrier,[3] and *Goniopecten*, Perrier.[4]

The diagnosis of *Benthopecten* is too brief even to indicate with certainty the subfamily to which it belongs.

Cheiraster probably finds its nearest ally in *Pontaster*, but is widely separated from that type by the truly remarkable position of the generative organs, which are said to be confined to the outer half of the ray in the form of a pair of long bands—an abnormal structural character, which is certainly not present in *Pontaster*. The polygonal plates of the paxillæ are likewise different. This position of the genitalia is so unusual that I should have been disposed to regard it as an error of observation had it been recorded by a less experienced and careful anatomist than Professor Studer.

Blakiaster is placed by Perrier in the family Archasteridæ, and it is on his authority that I now include it, for unfortunately both the description and the figure convey only a very imperfect idea of the structural and genetic characters of the form. It appears to be remarkably *Astropecten*-like in many respects, and it might ultimately turn out to belong to the family to which that genus gives the name. In fact I rather suspect that such will be the case, from the presence of the series of small plates intervening between the inferomarginal plates and the adambulacral plates; and Perrier's remark, "L'anus n'est pas distinct," seems to point in the same direction.

Goniopecten, as far as I can judge from the characters described—which are chiefly specific rather than generic—will probably be included in the subfamily Plutonasterinæ, one of the species approaching in many respects *Plutonaster;* but whether all the species can be retained in the one genus is somewhat doubtful. A more exhaustive study of their real structural characters might, however, place the group of species as a distinct subfamily of Archasteridæ—to be called the Goniopectininæ.

M. Perrier seems to have had much doubt as to the classificatory position of *Goniopecten*, as in the Liste Méthodique (Nouv. Arch., pp. 166–169) that genus is ranked in a distinct family, Goniopectinidæ, in the order "Stelleridæ valvulatæ" (*loc. cit.*, p. 168); whilst in the description of the species on p. 249 the genus *Goniopecten* is removed to the order "Stelleridæ paxillosæ," and is there placed in the family Archasteridæ. No explanation of this discrepancy is given. With this conflict of opinion on the part of the author, and only an imperfect generic diagnosis as a guide, it is obviously impossible at

[1] *Amer. Journ. Sci. and Arts*, Sept. 1884, vol. xxviii. p. 218.

[2] *Sitzungsber. naturforsch. Freunde Berlin*, 16. Oct. 1883, p. 130; *Anhang z. d. Abhandl. d. k. preuss. Akad. d. Wiss. Berlin*, vom Jahre 1884, p. 49, Taf. iv. figs. 8, *a*, *b*, *c;* Taf. v. figs. 9, *a*, *b*, *c*, *d*, *e*.

[3] *Bull. Mus. Comp. Zoöl.*, 1881, vol. ix. p. 28; *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi. p. 265, pl. ix. fig. 2.

[4] *Bull. Mus. Comp. Zoöl.*, 1881, vol. ix. p. 24; *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi. p. 249, pl. iv. figs. 4 and 5; pl. v. figs. 3 and 4; pl. vii. figs. 1 and 2.

present to arrive at a definite decision as to the true position of *Goniopecten*. The difficulty is further increased by Perrier himself remarking on the interesting link afforded by this form between *Astropecten* and the Pentagonasteridæ (*loc. cit.*, pp. 166, 250).

Whilst refraining from criticising in any carping spirit Studer's excellent description of *Luidiaster*,[1] which is stated by him to be an aproctuchous form with aborted supero-marginal plates, and ranked accordingly amongst the Astropectinidæ, I cannot escape from a strong suspicion, aroused by the consideration of the general characters of this interesting asterid, that when a further supply is available for study the genus *Luidiaster* may also find a place in the family Archasteridæ. The absence of the superambulacral plates ("epiambulacral" of Studer) is in direct support of this view. It would be interesting to know whether the papulæ are distributed over the abactinal surface or limited to special areas at the base of the rays. The general facies of the form leads me to infer that the latter will probably be the case, although this inference is purely conjectural, for I have no positive basis on which to make such a generalisation.

Subfamily Pararchasterinæ, Sladen, 1886.

Genus *Pararchaster*, Sladen.

Pararchaster, Sladen in Narr. Chall. Exp., 1885, vol. i. p. 610.[2]

Disk small. Rays very long, tapering, and flexible.

Marginal plates suboval or triangular, elongate in the direction of the ray, confined to the margin of the ray, the two series alternating more or less. Each plate with a prominent boss. Supero-marginal plates with one long cylindro-conical spine, and sometimes a companion present. Infero-marginal plates with one or more similar spines. The general surface of the plates of both series is nominally naked, or only with minute isolated spiniform thornlets.

A large odd interradial plate is present in both marginal series, the superior one with a prominent boss and a very large spine at the summit of the interbrachial arc.

Abactinal area with squamiform plates covered with skin, bearing one to three or more spicules or minute spinelets. No true paxillæ. No definite order of arrangement. Papulæ confined to an area at the base of the ray.

Actinal interradial areas with very few intermediate (ventral) plates. In some cases these are apparently wanting altogether; and are generally absent in young forms.

Armature of adambulacral plates consisting of:—(1.) a semicircular furrow series of small uniform spines, radiating fan-like; and (2.) one or more large conical outer spines on the actinal surface.

Madreporiform body close to the odd interradial marginal plate.

Peculiar comb-like pedicellariæ frequently present.

[1] *Sitzungsb. naturf. Freunde Berlin*, 16. Oct. 1883, p. 131; *Anhang z. d. Abhandl. d. k. preuss. Akad. d. Wiss. Berlin*, vom Jahre 1884, p. 46, Taf. iv. figs. 7, *a*, *b*, *c*, *d*.

[2] The Notes published in the "Narrative" of the voyage were in type in July 1884.

Genital foramina opening upon the abactinal surface close to the marginal plates on each side of the odd interradial plate.

Remarks.—The genus *Benthopecten*, recently described by Verrill,[1] is stated to be furnished with abactinal plates covered with skin, usually bearing a single spine or sometimes two or three, but not forming true paxillæ. This character would seem to indicate an alliance with *Pararchaster;* but from the brevity of the description I cannot say whether this be near or remote, and I am for the same reason unable to indicate in the foregoing synoptic table the relative position of the genus in the family. No mention is made of the presence of any odd interbrachial marginal plate and spine, or of the limitation of the papulæ to the basal region of the rays,—characters which are so conspicuous in *Pararchaster*, and whose importance from a structural point of view could scarcely have been overlooked by a naturalist so well acquainted with starfish anatomy as Professor Verrill, had they been present in *Benthopecten*. Furthermore, no mention is made of the presence of any pedicellarian apparatus. On the other hand it is recorded that "a circle of four to six papillæ, placed singly, surrounds each plate." If the word "papillæ" here stands for the organs which I call *papulæ* (following Stimpson), it would appear extremely doubtful whether *Benthopecten* would find a place even in the same subfamily as *Pararchaster*.

The subjoined scheme will assist in the ready recognition of the different species of the genus.

Synopsis of the Species included in the Genus Pararchaster *herein described.*

A. No pedicellariæ of any kind. Single spinelets on the abactinal plates.
  a. Abactinal area of disk plane. One supero-marginal spine. Adambulacral plates with two actinal spines. No line of thornlets on the infero-marginal plates . . . . . *semisquamatus.*
  b. Abactinal area of disk inflated. Two supero-marginal spines. Adambulacral plates with three actinal spines. A line of thornlets on the infero-marginal plates . . . . . *antarcticus.*

B. With special comb-formed pedicellariæ. Abactinal plates with one to three or more spinelets.
  a. With pedicellariæ between each infero-marginal plate . . . . *pedicifer.*
  b. With no pedicellariæ between the infero-marginal plates.
    a. One lateral spine on infero-marginal plates and a small companion. Adambulacral plates with six or seven furrow spines, one actinal and sometimes a small companion behind it. Abactinal plates with one or two spinelets, all simple. Comb-like pedicellariæ on the abactinal surface . . . . . *armatus.*
    b. Three or four lateral spines on infero-marginal plates. Adambulacral plates with four furrow spines, and two actinal side by side. Abactinal plates with several long needle-like spinelets interspersed amongst the simple ones. No comb-formed pedicellariæ on the abactinal surface . . . . . *spinosissimus.*

[1] *Amer. Journ. Sci. and Arts*, Sept. 1884, vol. xxviii. p. 218.

The asterid obtained during the "Blake" dredgings and described by Perrier[1] under the name of *Archaster simplex*, is without doubt a *Pararchaster*. It is, however, an immature form, and I am unable to say from the description given whether it belongs to an independent species or is the young of one of those herein described. The figure given[2] is altogether unlike the smallest example of *Pararchaster armatus* in the character of the armature both of the adambulacral and infero-marginal plates, and this appears to be the only form with which a direct comparison can be instituted. The description is too short to render any assistance in this case.

Chorology of the Genus Pararchaster.

α. *Geographical distribution*:—

Atlantic: Three species between the parallels of 50° N. and 10° S.

Pararchaster armatus and *Pararchaster semisquamatus*, var. *occidentalis*, off the coast of North America. *Pararchaster armatus* is also found off the coast of Portugal. *Pararchaster spinosissimus* off the Island of Ascension.

Pacific: One species between the parallels of 30° and 40° N.

Pararchaster semisquamatus, south of Japan.

Southern Ocean: Two species between the parallels of 30° and 70° S.

Pararchaster pedicifer between the Cape of Good Hope and Kerguelen Island. *Pararchaster antarcticus* in the region of the Antarctic Circle, near the meridian of 80° E. The latter species is nearly allied to a species in the North Atlantic and also in the North Pacific.

β. *Bathymetrical range*: 425 fathoms to 1900 fathoms.

All the species excepting one (*Pararchaster spinosissimus*) belong to the Abyssal zone. Two species only (*Pararchaster spinosissimus* and *Pararchaster semisquamatus*) occur in depths less than 1000 fathoms.

Greatest range of one species: *Pararchaster semisquamatus*, 565 to 1875 fathoms.

γ. *Nature of the Sea-bottom*: Three species, viz., *Pararchaster semisquamatus*, *Pararchaster antarcticus*, and *Pararchaster armatus*, on Blue mud; and *Pararchaster semisquamatus* is also found on the Green mud in 565 fathoms. *Pararchaster pedicifer* on Diatom ooze and Globigerina ooze; and *Pararchaster spinosissimus* on Volcanic sand in 425 fathoms.

[1] *Bull. Mus. Comp. Zoöl.*, 1881, vol. ix. p. 28; *Nouv. Archives Mus. Hist. Nat.*, 1884, 2e Sér., t. vi. p. 264.
[2] *Loc. cit.* pl. i. fig. 8.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Pararchaster armatus[1] . .	Atlantic.	1250 to 1350	Blue mud.
Pararchaster antarcticus .	Southern Ocean.	1675	Blue mud.
Pararchaster pedicifer . .	Southern Ocean.	1600 to 1900	Diatom ooze (1600 fathoms). Globigerina ooze (1900 fthms).
Pararchaster semisquamatus .	Pacific.	565 to 1875	Green mud (565 fathoms). Blue mud (1875 fathoms).
Pararchaster semisquamatus, var. *occidentalis*[2] . .	Atlantic.	1700 or 1240	Blue mud.
Pararchaster spinosissimus .	Atlantic.	425	Volcanic sand.

1. *Pararchaster semisquamatus*, n. sp. (Pl. II. figs. 1 and 2; Pl. IV. figs. 7 and 8).

Rays five. R = 166 mm.; r = 15 mm. R = 11 r. Breadth of a ray near the base, 14·5 mm.

Rays very elongate, comparatively narrow and flat, tapering gradually and slowly from the base to the extremity, the outer part being very attenuate. Disk very small. Abactinal surface plane, feebly convex or subcarinate along the median line of the rays. Lateral walls of the ray low and vertical. Actinal surface of the disk prominent at the mouth-angles, and sloping thence to the margin and very slightly along the rays. Interbrachial arcs widely rounded.

The abactinal surface of the disk and rays is covered with small, uniform, subcircular scale-like plates, which are overlaid with a delicate membranous tissue. The plates bear on their centre a single minute subconical or cylindrical spinelet; along the rays these are quite microscopic thornlets, but upon the disk and at the base of the rays there are a number of much larger spinelets; the largest are elongate, about 7 to 8 mm. in length, robust, tapering, and sharply pointed, and their position probably marks the primary apical plates; the primary radials and basals being especially distinguishable, and perhaps also the dorso-central and the under-basals; other spinelets rather smaller are present in the vicinity of these, but they rapidly decrease in size as they recede from the central area; and really definite spinelets do not extend further along the base of the ray than the third or fourth supero-marginal plate.

The supero-marginal plates, fifty-five in number from the median interradial line to the extremity, are elongate and suboval in form, and are confined entirely to the lateral wall of the ray; their posture appears slightly oblique when viewed from the side, the aboral end of one plate standing over the adoral end of the next outward; their height is

[1] The exact station off the coast of Portugal is not recorded.

[2] It is uncertain whether this species is from Station 44 or Station 45.

less than half their length; and the upper margin only of the plate forms the boundary of the abactinal surface of the ray. On the centre of each plate is a large well-defined tubercle, on which is articulated a robust, cylindrical, tapering spine, the ninth from the interradial line being about 8 mm. in length. The surface of the plate is covered with membrane and bears no spines, excepting occasionally a minute thornlet, irregularly placed near the base of the large spine.

In the median interradial line there is one large odd supero-marginal plate, developed abactinally into a prominent, truncate, conical tubercle, upon which is borne a powerful robust spine about 8 mm. in length, directed vertically, and thicker than any of the other spines on this species.

The infero-marginal plates are similar in form and character to the superior series, each being nearly exactly beneath its corresponding upper companion. Like them, each has a prominent tubercular eminence, upon which is borne a straight, robust, tapering, and sharply-pointed spine, the sixth or seventh from the interradial line measuring about 10 mm. in length; the length decreasing slightly as they proceed along the ray. A second similar but rather smaller spine, articulated on a tubercle, stands close to the lateral spine on the inner side. The surface of the plate is covered with membrane; and two or three irregularly placed microscopic thornlets may be present. On the two or three innermost plates on each side of the median interradial line, the lateral spines and their companions are greatly reduced in size, being little more than mere miliary spinelets.

In the interbrachial arcs, the marginal plates have the appearance of being brought over upon the disk; and their surface forms a peculiar bevelled area sloping outwards and downwards, the lower margin only of the infero-marginal plates falling in the outline of the interbrachial arc.

The adambulacral plates are large and massive, of great breadth, and rather broader than long. They are comparatively widely separate, and the interspaces are filled up with ligament; the furrow margin is slightly convex. Their armature consists of:—(1.) a furrow series of five very small, short, equal, cylindrical, obtusely pointed spinelets, which radiate apart and form a small isolated semicircular comb directed over the furrow, the successive combs being well spaced apart. (2.) On the actinal surface of the plate are two large, robust, tapering, but obtusely pointed spinelets, placed one behind the other, which are subequal in length, or occasionally the outermost is the longest; this measures 4 mm. on the sixth or eighth adambulacral plate, the longest spinelets of the furrow series not exceeding 1 mm. One minute thornlet usually stands on the adoral side of the outer of the two superficial spines; no other spinelets are present, and the surface of the plate is covered with a membranous tissue. The ambulacral furrows are comparatively widely open. The tube-feet are large, and have a rounded, well-developed, knob-like termination.

The mouth-plates are large, prominent, and convex actinally, presenting a broad and rounded, but centrally rather flattened, margin towards the actinostome; and the median suture of the pair is imperfectly closed. Their armature consists of a marginal series of five mouth-spines on each plate, the innermost one being twice or three times as long and robust as the others, which are subequal and rather widely spaced. On the actinal surface of each plate are three (or sometimes only two) robust tapering spinelets, standing wide apart and forming a line parallel to the median suture; these do not appear to attain the size of the superficial actinal spinelets on the adambulacral plates. The surface of the plates is covered with membrane, and no other spinelets are present.

The actinal interradial areas are of very small extent, and do not reach beyond the fifth adambulacral plate. The size and number of the intermediate or ventral plates is undeterminable in spirit specimens on account of the membrane with which they are overlaid. So far as can be judged, they appear to be comparatively large, and are certainly few in number. A few of these bear one, or occasionally two, small spinelets 1·5–2 mm. in length.

The anal aperture is subcentral but indistinct, surrounded by large spinelets.

The madreporiform body, which is large and oval, is situated midway between the centre of the disk and the odd interradial supero-marginal plate. Its surface is slightly convex, finely grooved with numerous highly convoluted striation furrows, and has on that account a remarkable resemblance to the "brain" coral. Several large spinelets surround its margin, the largest being at its adcentral end.

The papulæ are very small and numerous, but confined to an area at the base of the rays, which does not extend beyond the fourth supero-marginal plate. The area occupies nearly the whole breadth between the supero-marginal plates, and extends well upon the disk, but no papulæ are present along a broad band which traverses the median interradial line.

No pedicellariæ of any kind are found upon this species.

Colour in alcohol, a dirty bleached ashy grey.

Individual Variation.—There is a fragmentary specimen from Station 235, in a very bad condition, of a much smaller example than the type above described, in which the spines of the actinal surface generally are proportionately much more delicate. From their length and character, I am disposed to consider this a feature of individual or even locational variation, rather than a phase of growth; a remark, however, which is merely conjectural, for its validity could only be proved by the examination of a large series of specimens.

Localities.—Station 237. Off the coast of Japan, south of Kawatsu. June 17, 1875. Lat. 34° 37′ 0″ N., long. 140° 32′ 0″ E. Depth 1875 fathoms. Blue mud. Bottom temperature 35°·3 Fahr.; surface temperature 73°·0 Fahr.

Station 235. Off Japan, south of Omae saki. June 4, 1875. Lat. 34° 7′ 0″ N., long. 138° 0′ 0″ E. Depth 565 fathoms. Green mud. Bottom temperature 38°·1 Fahr.; surface temperature 73°·0 Fahr.

Remarks.—Pararchaster semisquamatus and *Pararchaster antarcticus* are readily distinguished from the other species of the genus by the absence of pedicellariæ and the simplicity of the spinulation of the abactinal plates. The differences between the two forms are discussed in detail in the description of *Pararchaster antarcticus*.

If these two species and the variety are viewed together as an independent or specially characterised type of the genus, their distribution is very remarkable and instructive, *Pararchaster semisquamatus* of the North Pacific being represented by a variety in the North Atlantic, whilst the closely-allied species *Pararchaster antarcticus*, from the Southern Ocean, presents some of the characters of the typical or Pacific form of *Pararchaster semisquamatus*, as well as some of those of its Atlantic variety *occidentalis*.

1*a*. *Pararchaster semisquamatus*, var. *occidentalis*, nov.

There is a single specimen from the western side of the North Atlantic, off the east coast of North America, which, although agreeing in a remarkable way in all essential points with the type just described, presents a number of variations which render it worthy in my opinion of nominal recognition,—in fact, it may ultimately prove to be a distinct species. At present, however, I hesitate from according it that rank on the slender evidence of a solitary and imperfect specimen, although the widely separated geographical position of the two dredging stations would certainly favour the adoption of such a course.

The two forms are almost exactly of the same size. In the Atlantic example—the variety under notice—the spines on the supero-marginal plates are distinctly thicker and more robust at the base, whilst those on the infero-marginal plates are relatively smaller than in the Pacific form (the type). The two large spines on the actinal surface of the adambulacral plates are also smaller and shorter. On the abactinal surface the single minute thornlet which springs from the centre of the abactinal plates is distinctly shorter and thicker—a circumstance which gives at first sight a finely tuberculate character to the abactinal area when viewed from above. The large spines in the central region of the disk are smaller and much less numerous than in the Japanese form, and do not extend to the base of the rays. The lateral wall at the summit of the interbrachial arc is much less bevelled towards the abactinal surface of the disk, and the marginal plates do not bend over so conspicuously as in the type figured. The infero-marginal plates appear proportionately smaller in their transverse dimensions; and the marginal or furrow series of spines on the adambulacral plates are slightly more delicate and elongate. The roughening of the surface of the large spines on the marginal plates and elsewhere is more

conspicuous and decided in the variety. The madreporiform body has not the slightly convex character noticed in the type, and less convolution is present in the striations, which have a more or less regular appearance of centrifugal radiation. The tube-feet have a smaller terminal knob.

Locality.—Station 44 or 45. Off the coast of North America, east of Delaware and Maryland.

Station 44. May 2, 1873. Lat. 37° 25′ 0″ N., long. 71° 40′ 0″ W. Depth 1700 fathoms. Blue mud. Bottom temperature 36°·2 Fahr.; surface temperature 56°·5 Fahr.

Station 45. May 3, 1873. Lat. 38° 34′ 0″ N., long. 72° 10′ 0″ W. Depth 1240 fathoms. Blue mud. Bottom temperature 37°·2 Fahr.; surface temperature 49°·5 Fahr.

2. *Pararchaster antarcticus*, n. sp.

This species is very closely allied to the preceding one, and it is not without some hesitation that I have ventured to place it as distinct, for unfortunately only two examples were obtained, one much broken and imperfect, the other immature. The former of these is consequently the only one available for comparison with the preceding species, and this it resembles so much in general character that I have not considered it necessary to give drawings of the mutilated specimen.

The form is smaller than *Pararchaster semisquamatus*, its minor radius measuring 11·5 mm. (All the rays are imperfect, and from what remains they appear to have been probably shorter and more tapering than in that species.) The abactinal area of the disk is slightly inflated and convex, instead of flat, and the general character of its spinulation accords much more closely with that of *Pararchaster semisquamatus*, var. *occidentalis*, than with the type-form of that species. The large spines upon the disk are confined entirely to the central area, and not many more than those on the basal, radial, under-basal, and dorso-central plates are present. The single central spinelet on the abactinal plates along the ray is short, robust, and subconical, and the plates appear comparatively larger in proportion to the size of the animal than in *Pararchaster semisquamatus*. The lateral walls at the summit of the interbrachial arc are vertical, and do not bend over to form a bevel on the abactinal surface. The lateral walls generally along the ray are low, giving the ray a very flat appearance. The supero-marginal plates beyond the sixth (from the odd median interradial plate) bear two spines side by side, which may be either equal or one less than the other; and even in those plates where this second spine is not present in the form of a definite large spine, it is represented by a small miliary spinelet, and of these there may also be one or more additional on the plates which bear the two large marginal spines. On the actinal surface of the adambulacral plates three large spines are not unfrequently present. On the surface of the infero-marginal plates, and parallel to the upper adoral sloping margin, is a lineal series of three to five small thorn-like denticles or spinelets, which, although sometimes less conspicuously marked, are still a

very striking feature when this form is compared with *Pararchaster semisquamatus*. The spinulation of the actinal surface is rather short and robust, and the spinelets which form the furrow series on the adambulacral plates are distinctly more cylindrical and robust, and show less tendency to radiate apart. The tube-feet have large, well-developed, button-like knobs at their distal extremity. The madreporiform body is large and oval, with much-convoluted striations.

Although this and the preceding species conform so closely in their general structure, the variations mentioned above, although slight when taken singly, seem to constitute an assemblage of characters which mark off this form specifically from *Pararchaster semisquamatus*. This view is strengthened by the fact that the characters are either indicated or present in the young form.

Young Phase.—A small example measuring only R = 20 mm., r = 4 mm., may be referred without hesitation to this species, so well are several of the characters noticed above as distinguishing the species indicated even at this early stage. The disk is slightly inflated, especially in the radial regions, and there are not more than about a dozen of the large spines in the central area, belonging to the primary apical plates. One or two small thornlets accompany the supero-marginal spine, although the largest of these latter is not more than 1·5 mm. in length. On the infero-marginal plates there is as yet only one true infero-marginal spine, but on each side of this and slightly below, there is regularly present a short thorn-like denticle or spinelet, and there is usually another above or beside it on the aboral side. The adambulacral plates have three spinelets on the furrow margin (occasionally four near the mouth), and two large spines on their actinal surface. The tube-feet have a large and well-developed terminal knob-like extremity. No actinal intermediate (ventral) plates are present. The madreporiform body is small, subcircular, slightly convex, and situated nearly midway between the centre of the disk and the margin: its surface is deeply fissured by a few coarse, convoluted striations. The anal aperture is distinct and a little excentral, *i.e.*, to the side of the dorso-central plate. Three moderate-sized spinelets stand round its margin. I have not been able to detect any papulæ in this example.

Colour in alcohol, a bleached yellowish white, with a slight brownish or warm ochre shade on the abactinal area of the disk.

Locality.—Station 153. In the Southern Ocean, amongst the pack ice, close to the Antarctic Circle. February 14, 1874. Lat. 65° 42′ 0″ S., long. 79° 49′ 0″ E. Depth 1675 fathoms. Blue mud. Surface temperature 29°·5 Fahr. This was the most southern dredging station during the expedition.

3. *Pararchaster spinosissimus*, n. sp. (Pl. I. figs. 1 and 2; Pl. IV. figs. 1 and 2).

Rays five. R = 66 mm.; r = 7·5—8 mm. R > 8r. Breadth of a ray near the base, 7·5 mm.

Rays elongate, delicate and attenuate, at first diminishing rather rapidly in width from the base, and then tapering gradually to the extremity. Their flexibility is great, the outer portion being usually recurved abactinally and curled up. The lateral walls are vertical, and the rays nearly rectangular in section. Disk small. Abactinal surface flat, highest over the disk and sloping thence along the rays. Actinal surface level, slightly rounded at the margins. Interbrachial arcs wide and well rounded.

The abactinal surface of the disk and rays is covered with small spicules overlaid with a delicate membranous tissue, and the majority bear a small but rather elongate, delicate, tapering, hair-like spinelet, with several minute cilia-like miliaries at the base. The central spines, as indeed the spinulation generally, diminish in size as they recede from the disk. Their delicacy on the disk is very remarkable. To a certain extent these spine-groups simulate paxillæ, but only very superficially; their structure and character being altogether different.

The supero-marginal plates, fifty-three in number from the median interradial line to the extremity, are elongate and confined to the lateral wall of the ray, their upper surface, which is bevelled and arched, forming a very narrow border to the abactinal area. In a few of the plates on the inner part of the ray the height is slightly greater than the length, but this proportion is soon reversed, and the length is the greater dimension along the rest of the ray. Each plate bears a convex elevation or low tubercule, upon which is articulated an elongate, delicate, tapering, and sharply pointed spine, the fourth or fifth from the median interradial line being the longest, measuring about 5 mm. in length; and they decrease gradually in length as they proceed along the ray. There are generally a few short, hair-like spinelets at the base of this spine, and a few widely spaced conical pointed granules on the surface of the plate, in the lateral or vertical wall of the ray. Midway on the ray and towards the extremity the supero-marginal plates have quite the appearance of tubercles on rounded bases, when viewed abactinally and slightly obliquely. The general surface of the plate is covered with a thin membrane.

In the median interradial line is a high odd supero-marginal plate prominently tubercular abactinally, upon which is borne an elongate, tolerably robust, tapering and sharply pointed spine, about 8 mm. in length, directed vertically. At the base of this spine are a few short, hair-like spines, and a few conical thornlets traverse the median area of the surface of the plate which falls in the vertical wall.

The infero-marginal plates have a tendency to alternate with the superior series. Each plate bears a row of three, or sometimes four, very delicate, hair-like, tapering spinelets, along its median transverse line; the uppermost or lateral spine is much more delicate and slightly shorter than the long spine on the supero-marginal plates, and the other spinelets decrease in size as they recede from the lateral; in addition to these there are several very delicate small hair-like spinelets upon the plates, and it is frequently difficult to distinguish between them and the main series just mentioned. A few miliary thornlets are also

present. With this armature the plates have a very echinulate appearance, and the delicacy of the spinelets is remarkable.

In the median interradial line is a high odd infero-marginal plate immediately below the odd supero-marginal plate. It bears a series of small delicate spinelets along its median vertical line.

The adambulacral plates are small, with their length equal to, or slightly greater than, their breadth. They are rather widely separate, the intermediate space being filled in with ligament; and there is a convex or subangular margin towards the furrow. Their armature consists of:—(1.) a furrow series of three or four small cylindrical spinelets forming an isolated little hand-like comb on the projecting margin; the fourth or aboral spinelet is often very small, and often absent altogether. (2.) On the actinal surface of the plate are two much longer delicate cylindrical spines, usually placed side by side, but sometimes more or less oblique, the adoral spine being rather more outward in its position than its companion. Occasionally a minute miliary thornlet may be present near the adoral and outer margin of the plate, but there are no other spinelets present. The actinal spines measure about 2 mm. in length near the base of the ray, and the marginal or furrow series are normally less than half this length.

The mouth-plates are large, and the united pair are broad, convex actinally, and with a prominent free margin towards the actinostome, its outline being more than a semicircle, and slightly flattened anteriorly. The armature consists of a marginal series of eight small cylindrical spinelets on each plate, the two innermost being longer and more robust than the others; the four innermost on each plate stand parallel to one another and are directed horizontally towards the centre of the actinostome. On the actinal surface of the plate are three or four cylindrical tapering spinelets more robust than the actinal spinelets on the adambulacral plates, arranged rather wide apart, and sometimes rather irregularly, in a line parallel to the median suture; and one or sometimes two similar and equal spines on the anterior part of the plate in the interspace between the lineal series just mentioned and the marginal series. No other spinelets are borne on the plates.

The actinal interradial areas are very small; and the intermediate plates are few in number and do not extend beyond the fifth adambulacral plate. There are usually two large spiracle-formed pedicellarian apparatus in each area, one on each side of the median line, which occupy nearly the whole space between the mouth-plates and the marginal plates; sometimes, however, only one is present; sometimes a second pair occur, rather smaller, and placed on each side of the odd infero-marginal plate, but sometimes in like manner only one of these is present. These double-combed or spiracle-like apparatus are larger and more complex in this species than in any other form I know; they are also composed of more numerous spinelets and the two opposing series are directed considerably upwards into the cavity of the apparatus, the external margins being prominent and apparently raised.

The anal aperture is subcentral and distinct.

The madreporiform body is rather small, oval or subcircular in outline, and is placed rather nearer the odd supero-marginal plate than midway between it and the centre of the disk. Its surface is usually level with the surrounding area, and is marked with numerous fine striation furrows which have the general appearance of radiating from the centre outwards. Several long and prominent spinelets surround the margin, and one larger than the rest stands at the adcentral side.

The papulæ are comparatively large and numerous, and occupy an area at the base of the rays which may stretch as far as the sixth or eighth supero-marginal plate, though seldom more than stragglers occur beyond the fifth even in large specimens: the papulæ also extend upon the disk, but are absent from the central region and along the median interradial lines.

There is a small genital aperture situated on each side of the odd supero-marginal plate, opposite the first paired supero-marginal plate, and opening on the abactinal surface close to its margin. The foramen is oval or subreniform, and is guarded by a simple papilliform spinelet, attached on the adcentral margin, and directed over the aperture outwards and consequently towards the marginal plate.

Colour in alcohol, a bleached greyish white.

Individual Variation.—So far as I am able to judge from the material at my disposal, this species appears very constant in general character. The following particulars seem to be noteworthy. In one example the disk is relatively large, the radial measurements being R = 60 mm.; r = 9 mm. It may be noticed also that in some cases one of the two large spinelets on the actinal surface of the adambulacral plates is either much reduced in size or may be absent altogether. One example presents a very interesting modification in the number and disposition of the large spiracle-formed pedicellarian apparatus on the actinal surface, these not being confined to the interradial area only, but three or four are distributed along the ray, standing between adjacent infero-marginal plates; on one side of a ray four are present as well as the normal interradial ones, and the outermost one observed stands between the eighth and ninth infero-marginal plates.

Locality.—Station 343. Off the Island of Ascension. March 27, 1876. Lat. 8° 3′ 0″ S., long. 14° 27′ 0″ W. Depth 425 fathoms. Volcanic sand. Bottom temperature 40°·3 Fahr.; surface temperature 80°·8 Fahr.

Remarks.—This extremely elegant form is at once distinguished from all the other species of *Pararchaster* by its delicately attenuate and flexible rays, and by its remarkably spinous character—the number and delicacy of the spinelets on the infero-marginal and abactinal plates forming a special and conspicuous feature.

4. *Pararchaster pedicifer*, n. sp. (Pl. I. figs. 3 and 4; Pl. IV. figs. 3 and 4).

Rays five. R = 165–168 mm.; r = 15·5 mm. R = 11 r. Breadth of a ray near the base, 14 mm.

Rays very elongate, narrow and depressed, tapering slowly from the base to the extremity; the outer part being very attenuate. Disk very small, abactinal surface more or less inflated, and with a well-defined tumidity at the base of the rays. Along the rays the abactinal surface is almost plane, being only very faintly convex along the median line. Lateral walls low, causing the rays to have a thin, flat appearance. Actinal surface of the disk prominent at the mouth-angles, and sloping thence to the margin. Interbrachial arcs wide and well-rounded.

The abactinal surface of the disk and rays is covered with a plating of small uniform spicules, overlaid with a membranous tissue. The spicules bear centrally one to four minute papilliform granules, scarcely worthy of being designated spinelets, but which are cylindrical and either truncate, denticulate, or subconical at the tip, with the membrane mounting their bases and more or less completely investing them. Those on the disk are scarcely larger than those on the rays. On the disk are ten short, cylindrical, tapering spinelets, about 3·5–4 mm. in length, regularly placed, their position probably marking the primary radial and basal plates. No other definite spines are present on the paxillar area. Upon the abactinal surface of the rays are a number of small pedicellarian apparatus, irregularly placed and consisting of two opposed series of three or four small spinelets, slightly longer than those on the spicules, the two series closing together against one another.

The supero-marginal plates, fifty-four or fifty-five in number from the median interradial line to the extremity, are elongate and confined entirely to the lateral wall of the ray. When viewed from the side their posture appears more or less oblique in consequence of the form of the infero-marginal plates. The length is greater than the height, and the upper margin of the plate, which alone forms the boundary of the abactinal surface, is slightly arched. Each plate bears centrally a well-developed tubercle upon which is articulated a tolerably robust, tapering, and pointed spine, the fourth or fifth from the interradial line measuring about 5 mm. in length. The surface of the plate is covered with membrane and there are usually four or five small, microscopic thornlets on the area intervening between the spine and the adoral margin of the plate, and occasionally one close to the base of the spine on the aboral side.

In the median interradial line there is one large high odd supero-marginal plate, which bears an elongate, cylindrical, tapering spine directed vertically, and larger than any of the other spines.

The infero-marginal plates correspond to the superior series, each being placed nearly exactly beneath its respective companion. They are elongate, but are higher than the supero-marginal plates and have a more or less subtriangular form when viewed from the side, the abactinal margin being angularly arched. Each bears a prominent tubercle, upon which is articulated an elongate, straight, cylindrical, tapering lateral spine, the fourth or fifth measuring about 6·5 mm. in length; the length diminishing slightly as they proceed along the ray. A second similar, but smaller and more delicate, spine, not more

than two-thirds its length, stands close to the lateral spine on the inner side, and is likewise articulated on a tubercle. The surface of the plate is covered with membrane, and there are a few widely spaced miliary thornlets on the vacant areas on each side of the spines. On the inner part of the ray, and especially on the innermost plates in the interbrachial arc, these assume the form of short, cylindrical, obtusely tipped spinelets. Occasionally also one of these near the base of the second lateral spine is longer than the rest, and then simulates a third (but very small) member of the infero-marginal armature.

In the median interradial line is a large and broad odd infero-marginal plate, corresponding to the odd supero-marginal plate. Its position is vertical, and this plate as well as the two next plates on either side bear no large lateral spines, but only two or three short aborted cylindrical spinelets and a few miliary spinelets or thornlets.

Between each successive infero-marginal plate is a rather large pedicellarian apparatus, at least along two-thirds the length of the ray; these are of the double comb or spiracle form, and consist of five or six short tapering spinelets borne on each of the adjacent plates, the two series being opposed to one another, and closing over the intervening cavity. The apparatus occupies nearly the whole of the vertical margins of the plates and comes close to the actinal margin.

The adambulacral plates are large, broad, and well-spaced, the breadth being slightly greater than the length. There is a small semicircular prominence into the furrow; and the armature consists of :—(1.) a furrow series of six to eight very small, short, cylindrical, obtusely tipped spinelets, all equal excepting the outermost at each end of the series, which are rather shorter. All are placed close together, and form a compact semicircular comb, the spinelets, when directed vertically, standing parallel to one another, and when directed over the furrow, radiating slightly apart. The successive combs are well spaced apart. (2.) On the actinal surface of the plate are three comparatively elongate, cylindrical, obtusely tipped spinelets, placed one behind the other in an oblique line, the outermost being usually smaller than the others, sometimes wanting, sometimes irregularly placed, and absent at the extremity of the ray. The longest of these spines is about 2·5 mm.; the marginal series not exceeding 1 mm. in length. No other spines or thornlets are present on the plate, and its surface is covered with membrane.

The ambulacral furrow is widely open, and the tube-feet are large, conical, and with a small knob-like termination.

The mouth-plates are large, prominent and convex actinally, the united pair being broad, with a flattened semicircular margin towards the actinostome. Their armature consists of a marginal series of six or seven mouth-spines on each plate, the innermost one being twice or three times the length and robustness of the others, which are subequal, all being cylindrical and obtusely tipped. On the actinal surface of the plate are three short, cylindrical, obtusely tipped spinelets, rather smaller than the actinal spines on the

adambulacral plates, widely spaced and standing in a subregular lineal series parallel to the median suture. On the anterior part of the plate are two or three isolated and much smaller spinelets, and there is usually a thornlet or miliary spinelet opposite the middle spine of the three main superficial mouth-spines, or opposite the interspace between the middle and the outermost. The surface of the plates is covered with membrane and no other spinelets are present.

The actinal interradial areas are very small, and do not extend beyond the third or fourth marginal plate, and probably not more than twelve or fifteen intermediate plates are present in each; but the exact number is undeterminable on account of the whole area being covered with membrane. Between each of the plates of the inner row is one of the spiracle-like pedicellarian apparatus, similar to those just described, but much larger; and there are thus five or six in each area. The few remaining intermediate or ventral plates bear one or two short, cylindrical, obtusely tipped spinelets.

The anal aperture is subcentral, small and very distinct; it is surrounded by small spinelets somewhat larger than the small spinelets on the spicules generally.

The madreporiform body which is comparatively large and oval, is situated a little on the outer side of midway between the centre of the disk and the margin. Its surface is sub-plane or very faintly convex, and is grooved with highly convoluted furrows, the general direction of the striations appearing to radiate from a central point to the margin.

The papulæ, which are rather large and distinct, are confined to an area at the base of the rays, which does not extend beyond the fourth supero-marginal plate, but reaches on the disk as far as the spine referred to as marking the primary radial plate. No papulæ are present on a band-like area along the median interradial line; and on the outer part of the papularium at the base of the ray, there is likewise a V-shaped area, with the angle passing far downward adcentrally along the median line, which is similarly devoid of papulæ.

Colour in alcohol, a bleached ashy white; with some traces of a brownish, or dark purple, pigment remaining upon the abactinal surface.

Individual Variation.—In some cases the small spinelets on the abactinal plates or spicules are very regularly grouped into threes or fours along the ray, excepting just at the sides. The regularity of this arrangement gives at first sight rather a striking feature. In other examples no such general grouping takes place, although here and there a faint approach to it may be noticed. The usual pedicellariæ are present in both instances. The second large spine on the infero-marginal plates is more definitely developed in some cases than others; and in some specimens when this spine is small its character is in a great degree masked by the presence of a companion smaller spinelet standing beside it, giving the appearance of a pair of small spinelets standing side by side below the true lateral spine.

Young Phase (?).—There is a very small specimen from Station 143 which is probably

the young of this species. At any rate it is undoubtedly a *Pararchaster*, the only example from the locality, and from its size and character is unquestionably a juvenile form. Its measurements are R = 14 mm., $r = 3{\cdot}5$–4 mm. There are twelve supero-marginal plates between the terminal and the median interradial plates, and the latter is very large. Four or five large spinelets are present in the central region of the disk, and there only appear to be single spinelets on the scale-like plates of the abactinal surface. There is one large spine on each marginal plate with usually a small thornlet on each side, and these are most definite on the inferior series. The adambulacral plates project with an acute angle into the furrow and there are not more than one or two spinelets of the furrow series, one being at the apex of the angle, and this is either the largest or the only one present. Near the mouth-plates are three spinelets in a few cases. On the actinal surface of the adambulacral plate there is one robust spinelet throughout, and this on the inner part of the ray is frequently accompanied by a second, which stands obliquely behind it. There are no actinal intermediate plates, and the odd interradial infero-marginal plate is very large, and might almost be mistaken at first sight for a single large intermediate or ventral plate; on its surface are several thornlets. The tube-feet have well-developed, proportionally large, button-like knobs at their extremity. The madreporiform body is rather nearer the margin than midway between that and the centre, and there are very few striation grooves upon it.

Localities.—Station 147. West of the Crozet Islands. December 30, 1873. Lat. 46° 16′ 0″ S., long. 48° 27′ 0″ E. Depth 1600 fathoms. Diatom ooze. Bottom temperature 34°·2 Fahr.; surface temperature 41°·0 Fahr.

Station 143. Off the Agulhas Bank, south of the Cape of Good Hope. December 19, 1873. Lat. 36° 48′ 0″ S., long. 19° 24′ 0″ E. Depth 1900 fathoms. Globigerina ooze. Bottom temperature 35°·6 Fahr.; surface temperature 73°·0 Fahr.

Remarks.—This species may be recognised unmistakably by the presence of the large comb-formed pedicellariæ between the infero-marginal plates, and is otherwise a well-marked form.

5. *Pararchaster armatus*, n. sp. (Pl. I. figs. 5 and 6; Pl. IV. figs. 5 and 6).

Rays five. R = 37 mm.; $r = 6$ mm. $R > 6\,r$. Breadth of a ray between the second and third supero-marginal plates, 4 mm.

Rays elongate, narrow and attenuate outwardly, tapering from the base to the extremity; subdepressed, with low vertical walls, and consequently nearly rectangular in section. Disk small. Abactinal surface flat and level. Actinal surface very slightly prominent at the mouth-angles. Interbrachial arcs wide and well-rounded.

The abactinal surface of the disk and rays is covered with a plating of small, thin, subcircular spicules, overlaid with a delicate membranous tissue. The spicules bear

centrally one, or sometimes two, and rarely three, very small papilliform thornlets, of uniform character throughout, excepting a few on the disk which are slightly larger, but still quite inconspicuous and unnoticeable without close examination. Occasionally in some examples two or three pedicellarian apparatus may be present,—these are of the double comb or spiracle-like form; their structure is very simple, and the spinelets composing them are comparatively large, in fact, slightly larger than the small thornlets usually borne on the spicules.

The supero-marginal plates, twenty-three to twenty-five in number from the median interradial line to the extremity, are elongate and low. The length is about three times greater than the height, and the upper margin of the plate, though actually confined to the lateral wall of the ray, is very slightly bevelled upon the abactinal surface. Each plate bears centrally on this margin a rather prominent tubercle, upon which is articulated an elongate, tapering, sharply pointed spine, the third or fourth from the interradial line measuring about 4·5–5 mm. in length. There are generally one or two small thornlets near the base of the spine, otherwise the surface of the plate is simply covered with a very thin membranous tissue. In the median interradial line is a high, odd, supero-marginal plate, thick and tubercular abactinally, which bears an elongate, cylindrical, tapering spine, about 8 mm. in length, directed vertically. On the vertical wall of the plate which stands in the interbrachial arc are a number of minute, conical, sharply-pointed granules, usually along the median area; and the one or two neighbouring plates on each side are likewise similarly, but irregularly and more sparsely, granulated.

The infero-marginal plates are elongate and low like the supero-marginal series, to which they correspond. Each plate bears a straight, tapering, lateral spine articulated on a tubercle, and usually more delicate and often shorter than the spine on the accompanying supero-marginal plate. A second but much smaller spine is sometimes present on the inner side, usually in the larger examples, but it is often wanting altogether, and seldom appears on the inner part of the ray and towards the extremity. Occasionally one or two microscopic miliary thornlets are present on the plate, and the surface of the plate is covered with a delicate membranous tissue.

In the median interradial line there is a large, broad, odd infero-marginal plate, larger and broader than any of the others; it is placed immediately beneath the odd supero-marginal plate. It bears a small representative of the lateral spine, and in addition several delicate miliary spinelets and thornlets. The one or two next plates on each side are likewise frequently more spinulate than any of the others.

The adambulacral plates are large in proportion to the size of the star fish, their length slightly exceeds their breadth, and they present a prominent and rather abrupt convexity into the furrow. Their armature consists of:—(1.) a furrow series of five to seven small, short, cylindrical, obtusely tipped spinelets, subequal excepting the extremities of the series, which are rather shorter; all are closely placed and form compact isolated little combs.

(2.) On the actinal surface of the plate is one comparatively large spinelet, robust at the base, and tapering to a pointed extremity; on the outer side of this a second, but smaller and more delicate, spinelet is present, and frequently also a small miliary spinelet on the adoral side of the large spinelet. The presence, however, of the second spine and of the miliary is by no means constant. They are often (perhaps usually) absent in small examples and on the inner and outer parts of the ray even of large specimens. The larger actinal spine measures about 1·7 mm. in length on the fifth or sixth plate from the mouth-angle, the marginal or furrow series being normally less than half this length.

The mouth-plates are large, and convex actinally, and the united pair form a broad projection towards the actinostome, the free margin being more than a semicircle, and bulging laterally. The armature consists of a marginal series of five, or sometimes six, short, slightly tapering mouth-spines on each plate, the innermost being twice as large as the others. On the actinal surface of the plate are three subequal tapering spinelets, forming a line parallel to the imperfectly closed median suture; sometimes a fourth is present on the outer side of the series, and sometimes its place is occupied by a miliary thornlet only; but often it is wanting altogether. No other spines are present, and the surface of the plates is covered with thin membrane.

The actinal interradial areas are very small indeed, not more than three or four intermediate plates being present in young examples, and in larger ones not more than eight to ten. These form only a single series between the marginal plates and the adambulacral and mouth-plates; their surface is covered with membrane and the larger plates bear two or three small thornlets. There is usually one small pedicellarian apparatus in each area, which does not stand in the median interradial line, but is usually separated therefrom by one plate. It is of the "spiracle"-like or double-comb form, previously described. Rarely two are present. There are no pedicellarian apparatus between the infero-marginal plates.

The anal aperture is subcentral and distinct, and usually there are two or three spinelets in its neighbourhood larger than those borne on the spicules generally.

The madreporiform body is comparatively large and oval, placed about midway between the centre of the disk and the margin, and its surface is conspicuously convex and is grooved with deeply cut and highly convoluted striation furrows.

The papulæ are tolerably numerous, but are large and distinct and limited to a small area at the base of the ray, which does not extend outwardly beyond the first supero-marginal after the odd interradial plate, and its inward extent on the disk would be bounded by a circle drawn upon the disk, with its margin touching the inner edge of the madreporiform body.

Colour in alcohol, a bleached ashy white.

Individual Variation.—In some examples a second infero-marginal spine, standing below the true lateral spine, is much more strongly developed than in others, and this in specimens of the same size and from the same locality. In others again it is repre-

sented only by a small miliary spinelet, or may be entirely absent altogether. I have only found them well-developed in one case, and that not the largest specimen in the series. In one example I notice a tendency towards diminution in the number of spinelets in the furrow series on the adambulacral plates, and this is shown in the abortion or total absence of the outer spinelets at either extremity of the series; as a result of this reduction there may be only three, four, or five spinelets in place of six, which appears to be the normal number, and the central spinelets of the series appear comparatively long. The occasional presence of an additional spine on the actinal surface of the adambulacral plates has already been remarked upon.

Young Phase.—The smallest example in the collection (from Station 46) has a minor radial measurement of 3·5 mm., and the rays appear to be comparatively robust. This specimen presents in a most unequivocal manner all the characters of the type, and even though so young there need not be the slightest hesitation about referring the form to this species. So small indeed are the differences between the juvenile and the adult stages, that the mature form in this species may well be said to exhibit on a larger scale all the features of the embryonic phase.

In this juvenile example there are no actinal intermediate (ventral) plates. The disk and the base of the rays have a somewhat villous or subpapillose appearance, the spinelets on the abactinal plates being decidedly robust for the size of the animal, and rather thickly covered with membrane. The papulæ are well-developed and distinct; and there are three large spiracle-formed pedicellarian apparatus on the disk. The odd interradial plates and spines are very large, the latter being about 5 mm. long; and are strongly denticulate along the shaft, suggesting to a certain degree the miniature of a *Cidaris*-spine. The knob-like terminations of the tube-feet are large and button-shaped. The genital foramina are discernible on each side of the odd interradial plate, opposite the first supero-marginal plates and near their inner edge.

Localities.—Station 50. South of Halifax, Nova Scotia. May 21, 1873. Lat. 42° 8′ 0″ N., long. 63° 39′ 0″ W. Depth 1250 fathoms. Blue mud. Bottom temperature 38°·0 Fahr.; surface temperature 45°·0 Fahr.

Station 46. Off the coast of North America, east of New Jersey. May 6, 1873. Lat. 40° 17′ 0″ N., long. 66° 48′ 0″ W. Depth 1350 fathoms. Blue mud. Bottom temperature 37°·2 Fahr.; surface temperature 40°·0 Fahr.

Station off the coast of Portugal. January 1873. (Exact date and station not recorded.)

Remarks.—*Pararchaster armatus* is characterised by the presence of comb-formed pedicellariæ on the abactinal area and in the actinal interradial areas, and by their absence between the infero-marginal plates. The simplicity of the armature of the infero-marginal plates (one lateral spine and sometimes a small companion), and the comparatively large number of six or seven spines in the furrow series on the adambulacral plates, also serve to readily distinguish this interesting form.

Genus *Pontaster*, Sladen.

Pontaster, Sladen in Narr. Chall. Exp., 1885, vol. i. p. 610.

Disk small. Rays long and tapering.

Marginal plates forming a definite vertical wall or a well-rounded margin. Often elongately oval, or subtriangular in form. The two series have a tendency to alternate more or less, which causes the horizontal margin that touches the companion series of plates to be more or less definitely angulated or to form two facets. Supero-marginal plates usually with one prominent well-developed spine. Infero-marginal plates with one to three similar prominent spines. On the general surface of the plates of both series are borne minute spiniform granules or miliary spinelets.

Abactinal area with round squamiform plates, bearing more or less well-defined paxillæ. No definite order of arrangement. Papulæ confined to an area at the base of the ray, frequently associated with a special calcareous structure of the skeleton—the papularium.

Actinal interradial areas with very few intermediate (ventral) plates.

Armature of adambulacral plates consisting of:—(1.) a semicircular furrow series of small spines; and (2.) one to three outer spines on the actinal surface, usually larger and conical; and a few miliaries may also be present.

Madreporiform body small, usually near the margin, but sometimes nearly midway between the margin and the centre of the disk.

Pedicellariæ frequently present, sometimes comb-formed, sometimes quadrivalvate, sometimes bivalvate.

Remarks.—The type of this genus is the starfish originally described by Düben and Koren[1] under the name of *Astropecten tenuispinus*, which was subsequently referred by Sars[2] to the genus *Archaster*, a determination which has been followed by the majority of the succeeding writers. Reference has already been made (p. 1 of this Report) to the incongruous character of the assemblage of species that have been included in the genus *Archaster* of Müller and Troschel, and in my remarks under the head of that genus (below, p. 121) will be found a further expression of my views as to the only species that can be retained under the generic name of *Archaster*. These conclusions are arrived at after a careful study of the structure and anatomy of the forms; and in the present place it is unnecessary to recapitulate the grounds upon which the limitation of the genus is based. A glance at the diagnosis of the genus given above, and of that of *Archaster* (*sensu stricto*) as formulated on a subsequent page, is sufficient to indicate that the two types are widely separate and can certainly not be classed as factors of the same generic term.

[1] *K. Svensk. Vetensk.-Akad. Handl.*, År 1844 (1846), p. 251, pl. viii. figs. 20–22.

[2] Oversigt af Norges Echinodermer, Christiania, 1861, p. 38, pl. iii. figs. 5–7.

A large number of recently discovered species are associated together by community of character in the genus *Pontaster*.

The following scheme will serve as an index of reference to their "special marks":—

Synopsis of the Species included in the Genus Pontaster *herein described.*

A. Adambulacral plates with a secondary series of two or more spines.
  a. Secondary spines on adambulacral plates large and robust; in oblique transverse series. With more or less well-developed dorsal spines on the supero-marginal plates.
    a. One infero-marginal spine and sometimes a small companion. With no large spines on the disk. No comb-formed pedicellariæ.
      α. With narrow marginal plates confined entirely to the lateral wall.
        i. With pedicellariæ. Disk large, rays much expanded at the base . . . . . *tenuispinus.*
        ii. With no pedicellariæ. Disk small, rays not much expanded at the base.
          1. With very fine needle-like spinulation . . *planeta.*
          2. With robust truncate spines . . . *hebitus.*
      β. With broad marginal plates forming a well-defined border on the abactinal surface. No pedicellariæ . . . *limbatus.*
    b. Three infero-marginal spines. With large spines on the disk. With comb-formed pedicellariæ . . . . . *oxyacanthus.*
  b. Secondary spines on the adambulacral plates small, and equal to the furrow series; in two converging series. With no dorsal spines on the supero-marginal plates, or only small ones here and there. . . *teres.*

B. Adambulacral plates with a secondary series consisting of only one large conical spine.
  a. With narrow supero-marginal plates.
    a. With quadrivalvate pedicellariæ. Paxillæ well-developed, with several spinelets.
      α. Pedicellariæ numerous on the abactinal surface, and on the actinal surface extending along the ray on the infero-marginal plates. Infero-marginal plates with close conical granulation. No secondary lateral spinelet . *forcipatus.*
      β. Pedicellariæ few, only present on the actinal interradial area. Infero-marginal plates almost naked. A well-developed secondary lateral spine present . . . . . *mimicus.*
    b. No pedicellariæ. Paxillæ on the outer part of the ray represented only by a squamous plate with a single central spinelet . . *pristinus.*
  b. With broad supero-marginal plates. No quadrivalvate pedicellariæ.
    a. Dorsal spines on the supero-marginal plates long, tapering and robust.
      α. Paxillæ with a central spine, often long and conical. No pedicellariæ. Actinal intermediate plates present . *venustus.*
      β. Paxillæ with no central spine, simple. Comb-formed pedicellariæ. No actinal intermediate plates . . . *trullipes.*
    b. No dorsal spines, only tubercles. No pedicellariæ present . . *subtuberculatus.*

The species from the "Blake" dredgings, described by Perrier[1] under the name of *Archaster mirabilis*, appears to me without any doubt to belong to the genus *Pontaster*. From the description given, however, I do not feel in a position to assign with accuracy its position in the preceding scheme, and the illustrations render no assistance towards that end. All the figures are stated in the explanation of the plates to be varieties of the form. Several of them, as shown by the phototype, appear very dissimilar in general facies. So far as I am able to judge from the characters mentioned, the form is well distinguished from any of the species herein described. The presence of the papulæ at the base of the rays appears to have been observed by Perrier, by whom, however, these organs were supposed dubiously to be genital orifices (*loc. cit.*, pp. 258–260).

In the subsequently published preliminary note on the starfishes dredged by the "Talisman," M. Perrier[2] has occasion to mention this species, and then refers it, either generically or subgenerically, to *Cheiraster* (the name being written "*Archaster* (*Cheiraster*) *mirabilis*, E. P."). I am somewhat at a loss to understand this, unless the inaccuracy of Studer's observations as to the remarkable position of the generative organs in the form of a pair of band-like structures along the distal or outer half of the ray—the main character upon which the genus rests—has been proved. For obviously the generative organs could not in one single species hold two such opposite and abnormal positions as that supposed by Perrier in the case of his *Archaster mirabilis*, and that described by Studer[3] in his *Cheiraster gazellæ* and *Cheiraster pedicellaris*.

I have previously referred briefly (*ante*, pp. 3, 4) to the remarkable characters that are specially regarded by Studer as distinguishing the genera *Cheiraster* and *Luidiaster*; and I would here only draw attention to the striking concordance these forms present in their general facies and the formula of their secondary characters with the genus under notice, if the extraordinary structures upon which their generic claim is based be excepted. I may even mention that in some of the species of *Pontaster* the position assigned by Studer to the structures which he considers to be generative organs in *Cheiraster* is occupied by a pair of strongly developed muscular bands, which present superficially all the appearances noted by Studer.

I am under the impression that *Archaster coronatus*, Perrier,[4] and *Archaster echinulatus*, Perrier,[5] will also be found to belong to the genus *Pontaster*, and perhaps *Archaster pulcher*, Perrier,[6] may in like manner be included in the same category, though as regards

[1] *Bull. Mus. Comp. Zoöl.*, 1881, vol. ix. p. 27; *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi. p. 256, pl. viii. figs. 7, 8; pl. ix. fig. 4; pl. x. figs. 2, 3, and 5.

[2] *Comptes rendus*, 1885, t. ci. p. 884.

[3] *Sitzungsb. naturf. Freunde Berlin*, 16. Oct. 1883, pp. 130, 131; *Anhang z. d. Abhandl. d. k. preuss. Akad. d. Wiss. Berlin*, vom Jahre 1884, pp. 50, 51, Taf. iv. figs. 8, *a*, *b*, *c*; Taf. v. figs. 9, *a*, *b*, *c*, *d*, *e*.

[4] *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi. p. 262.

[5] *Révis. Stell.*, p. 348 (*Archives de Zool. expér.*, 1876, t. v. p. 268); *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi. p. 263.

[6] *Bull. Mus. Comp. Zoöl.*, 1881, vol. ix. p. 26; *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi. p. 254, pl. ix. fig. 3.

this last species I offer the suggestion with much doubt, for the description given is altogether inadequate for classificatory purposes. I am unable to recognise any of these forms amongst the Challenger material.

Of the several new species from the North-American coast described by Verrill during the last few years under the generic name of *Archaster*, none appear to belong to the genus *Pontaster*. I would, however, suggest that the Asterid from this region which has been referred to *Archaster tenuispinus* may perhaps be found to be the same as the form I have named *Pontaster hebitus*.

Chorology of the Genus Pontaster.

a. Geographical distribution:—

Atlantic: Six species between the parallels of 80° N. and 40° S.

Pontaster forcipatus and *Pontaster hebitus*, off the coast of North America. *Pontaster limbatus* in the Faeröe Channel, off the west coast of Ireland and S.W. of the Scilly Islands. *Pontaster tenuispinus* in the Faeröe Channel, off the Scandinavian coasts, and as far north as Spitzbergen. (Also Greenland *fide* Lütken, and North America *fide* Verrill.) *Pontaster tenuispinus*, var. *platynota*, in the Faeröe Channel and off the west coast of Ireland. *Pontaster venustus*, east of the Azores, and *Pontaster venustus*, var. *robusta*, off the Cape Verde Islands. *Pontaster pristinus*, off the eastern coast of South America.

Pacific: Four species between the parallels of 40° N. and 50° S.

Pontaster oxyacanthus, south of Japan. *Pontaster trullipes*, west of the island of Luzon (Philippines). *Pontaster subtuberculatus*, east of Australia. *Pontaster planeta*, west of South America, near the entrance to the Straits of Magellan.

Eastern Archipelago: Two species between the parallels of 0° and 10° S.

Pontaster mimicus in the Arafura Sea. *Pontaster teres*, in the Banda Sea, between the Ki Islands and Banda Islands.

Southern Ocean: One species between the parallels of 40° and 50° S.

Pontaster forcipatus, var. *echinata*, between Marion Island and the Crozet Islands.

β. Bathymetrical range: 70 fathoms to 2650 fathoms.

Six species are found above the Abyssal zone (*i.e.*, in depths less than 500 fathoms), viz., *Pontaster hebitus, Pontaster limbatus, Pontaster oxyacanthus, Pontaster planeta, Pontaster tenuispinus*, with its var. *platynota*, and *Pontaster*

teres. Of these only one species, *Pontaster tenuispinus*, with its variety *platynota*, extends into the Abyssal zone.

Seven species are found in the Abyssal zone, viz., *Pontaster forcipatus* and its variety *echinata*, *Pontaster mimicus*, *Pontaster pristinus*, *Pontaster subtuberculatus*, *Pontaster tenuispinus* and its var. *platynota*, *Pontaster trullipes*, and *Pontaster venustus*. Four of these are found in depths greater than 1000 fathoms, viz., *Pontaster forcipatus* and its variety *echinata*, *Pontaster pristinus*, *Pontaster trullipes*, and *Pontaster venustus*.

Greatest range of one species: *Pontaster venustus*, 900 to 2025 fathoms.

γ. *Nature of the Sea-bottom:* Five species, viz., *Pontaster forcipatus*, *Pontaster planeta*, *Pontaster pristinus*, *Pontaster teres*, and *Pontaster trullipes*, are found on Blue mud only, excepting the variety *echinata* of *Pontaster forcipatus*, which is found on Globigerina ooze. *Pontaster venustus* is found on Globigerina ooze and Pteropod ooze. Three species are found on Green mud only, viz., *Pontaster mimicus*, *Pontaster oxyacanthus*, and *Pontaster subtuberculatus*. *Pontaster tenuispinus* and *Pontaster limbatus*, in the Continental zone, occur on various bottoms. *Pontaster hebitus* on gravel and stones.

Chorological Synopsis of the Species.

	Ocean.	Range in fathoms.	Nature of the Sea-bottom.
Pontaster forcipatus	Atlantic.	1240 to 1700	Blue mud.
Pontaster forcipatus, var. *echinata*	Southern Ocean.	1375	Globigerina ooze.
Pontaster hebitus	Atlantic.	85	Gravel, stones.
Pontaster limbatus	Atlantic.	100 to 440	.....
Pontaster mimicus	Eastern Archipelago.	800	Green mud.
Pontaster oxyacanthus	Pacific.	345	Green mud.
Pontaster planeta	Pacific.	245	Blue mud.
Pontaster pristinus	Atlantic.	2650	Blue mud.
Pontaster subtuberculatus	Pacific.	950	Green mud.
Pontaster tenuispinus	Atlantic.	70 to 778[1]	.....
Pontaster tenuispinus, var. *platynota*	Atlantic.	100 to 608	.....
Pontaster teres	Eastern Archipelago.	140	Blue mud.
Pontaster trullipes	Pacific.	1050	Blue mud.
Pontaster venustus	Atlantic.	900 to 2025	Pteropod ooze (900 fathoms). Globigerina ooze (2025 fathoms).
Pontaster venustus, var. *robusta*	Atlantic.	...	.....

[1] These two limits are given on the authority of Danielssen and Koren. Den Norske Nordhavs-Expedtion, Zoologi. xi. Asteroidea, Christiania, 1884.

1. *Pontaster tenuispinus*, Düben and Koren, sp.

Astropecten tenuispinus, Düben and Koren, 1846, Öfversigt af Skandinaviens Echinodermer: Kongl. Vetensk.-Akad. Handl., År 1844, p. 251, pl. viii. figs. 20–22.

Archaster tenuispinus, Sars, 1861, Oversigt af Norges Echinodermer, Christiania, 1861, p. 38, pl. iii. figs. 5–7.

(All succeeding writers have followed one or the other of these determinations.)

This species, as indicated above, was originally classed as an *Astropecten*, and afterwards as an *Archaster*. I have already briefly pointed out on a preceding page in my remarks on the genus *Pontaster* that the morphological characters of this form do not accord with those of either of the types to which it has previously been referred. The generic diagnosis will sufficiently indicate the great difference in structure of this form, and will at the same time bear evidence to the laxity of definition which has of late years been entertained with regard to the conception of the generic limits of *Archaster*.

This characteristic North-Atlantic Asterid has been well and unmistakably described by its discoverers Düben and Koren,[1] and subsequently by M. Sars,[2] Lütken,[3] and Danielssen and Koren,[4] each of whom has added successively to our knowledge of its anatomy and form. It is therefore unnecessary in the present place to recapitulate the diagnosis of the species. Unfortunately, the material at my disposal is not sufficient to enable me to indicate with satisfaction to myself either the range of the minor individual variations to which the type-form is subject, or the details of the characters of the young phases. This deficiency may, however, be supplied to a certain extent from other sources; and to this end I will limit myself to the remark that the descriptions given by Düben and Koren, and Sars, apply to young examples of the species; whilst that of Lütken is founded on specimens of larger growth, if indeed they do not actually belong to the variety indicated below. Of the probability of this being the case I have a very strong suspicion. It may, furthermore, be observed that the type is perhaps the strictly northern form, which is found on the Scandinavian and Greenland coasts; and that the variety frequents the more southern habitats, and is also perhaps the deep-water form.

Localities.—"Lightning" Expedition:

Station 6.[5] In the Faeröe Channel. Lat. 60° 45′ 0″ N., long. 4° 49′ 0″ W. Depth 510 fathoms. Bottom temperature 0°·5 C.

"Porcupine" Expedition:

Station 76.[5] In the Faeröe Channel. Lat. 60° 36′ 0″ N., long. 3° 58′ 0″ W. Depth 344 fathoms. Bottom temperature 1°·1 C.; surface temperature 10°·1 C.

[1] *K. Svensk. Vetensk.-Akad. Handl.*, År 1844 (1846), p. 251, pl. viii. figs. 20–22.

[2] Oversigt af Norges Echinodermer, Christiania, 1861, p. 38, pl. iii. figs. 5–7.

[3] *Videnskab. Medd. naturh. Foren. i Kjøbenhavn*, 1871, p. 240.

[4] *Nyt Mag. f. Naturvidensk.*, Bd. xxiii. 3die Hefte, 1877, p. 59, pl. iii. fig. 8; Den Norske Nordhavs-Expedition, 1876–1878, Zoologi. xi. Asteroidea, Christiania, 1884, p. 85.

[5] These occurrences are recorded in Sir Wyville Thomson's Depths of the Sea; but I have not seen the specimens.

Station 90.[1] In the Faeröe Channel. Lat. 59° 41′ 0″ N., long. 7° 34′ 0″ W. Depth 458 fathoms. Bottom temperature 7°·3 C.; surface temperature 11°·7 C.

Station 65. In the Faeröe Channel. Lat. 61° 10′ 0″ N., long. 2° 21′ 0″ W. Depth 345 fathoms. Bottom temperature 1°·1 C.; surface temperature 11°·1 C.

1*a*. *Pontaster tenuispinus*, var. *platynota*, nov. (Pl. VI. fig. 7; Pl. VII. figs. 3 and 4).

There appear to be at least two well-marked forms of *Pontaster tenuispinus*, one of which may be looked upon as typical and the other as representing a variety, which for convenience of reference may appropriately be spoken of as *Pontaster tenuispinus*, var. *platynota*.

The variety is characterised by its large disk, by the rapid attenuation of the rays at a short distance above their base, by the numerous large spines on the actinal surface of the adambulacral plates, and indeed by the well-developed spinulation of the actinal surface generally. Several well-developed spinelets are frequently present on the supero-marginal plates, and the number of spinelets composing the paxillæ on the disk is greater. It is further to be noted that the two-jawed pedicellariæ on the adambulacral plates are usually specially developed and large, the jaws being widely dilated and spatuliform, or of a pronounced spoon-bill shape. The habit of the variety is much larger than that of any examples which I have seen of the type-form.

Remarkably fine specimens have been procured from the cold water area in the Faeröe Channel in depths of 363 to 608 fathoms, and well-marked examples of the variety were likewise obtained off Valentia in 100 to 150 fathoms.

These latter show at the same time a facies of their own, the result of the association of several trivial but well-marked differences, which, although scarcely definable separately, are sufficient to produce a characteristic aspect whereby the specimens from this locality may be distinguished from any others with which I have compared them. At one time I was under the impression that the large-disked forms were only an older or more luxuriant stage of growth of the examples which I have called the type-form, and I recorded these specimens in my Reports upon the Asteroidea of the "Knight Errant"[2] and "Triton"[3] cruises under the simple name of *Archaster tenuispinus;* but after a careful study of the series which I have had the opportunity of examining, it seems undeniable that this explanation is not sufficient to account for the differences, because the smallest specimen in my possession—which measures R=11 mm., *r*=3 mm.—already presents characters which show that it belongs unquestionably to the variety. This circumstance has strengthened my decision in recognising the form as a well-marked and nameworthy variety.

[1] This occurrence is recorded in Sir Wyville Thomson's Depths of the Sea; but I have not seen a specimen.

[2] *Proc. Roy. Soc. Edin.*, 1881–82, vol. xi. p. 699. [3] *Trans. Roy. Soc. Edin.*, 1883, vol. xxxii. p. 154.

Young Phase.—In the small example above referred to (from Station 9 of the "Triton" dredgings, 608 fathoms), the spinulation of the abactinal surface is decidedly papilliform and well-developed. On the adambulacral plates there are already two large spines on the actinal surface, together with traces of a small companion in the same series. There are five or six spinelets in the furrow series. The pedicellaria is large and already characteristic. On the mouth-plates there is a marginal series of eight spines on each, the innermost being much larger and stouter than the others. The paxillæ of the abactinal surface are comparatively large and compact, composed of low robust papilliform spinelets, of which in the largest paxillæ there are from nine to twelve. The central one, when present, is equal to the others, and not large and prominent, as in the adult. The anal aperture is large and distinct, and decidedly excentral in position.

Localities.—"Porcupine" Expedition:

Station 54. In the Faeröe Channel. Lat. 59° 56′ 0″ N., long. 6° 27′ 0″ W. Depth 363 fathoms. Bottom temperature 0°·3 C.; surface temperature 11°·4 C.

Off Valentia, 100–150 fathoms.

"Knight Errant" Expedition:

Station 8. In the Faeröe Channel. August 17, 1880. Lat. 60° 3′ 0″ N., long. 5° 51′ 0″ W. Depth 540 fathoms. Ooze. Bottom temperature 29°·2 Fahr.; surface temperature 56°·5 Fahr.

"Triton" Expedition:

Station 9. In the Faeröe Channel. August 23, 1882. Lat. 60° 5′ 0″ N., long. 6° 21′ 0″ W. Depth 608 fathoms. Bottom temperature 30°·0 Fahr.

2. *Pontaster planeta*, n. sp. (Pl. X. figs. 1 and 2; Pl. XIII. figs. 1 and 2).

Rays five. R=37 mm., r=6·5 mm. R > 5·5r. Breadth of the ray near the base, 6 mm.

Rays elongate, narrow, tapering continuously up to the extremity. Interbrachial arcs well rounded. Abactinal surface subplane, slightly convex along the median radial line. Actinal surface of disk convex, prominent at the mouth-angles, sloping thence to the margin, and slightly along the rays to the extremity.

The paxillæ of the abactinal surface are small, numerous, and tolerably well spaced. Midway along the ray the crown is composed of four to six short papilliform spinelets, the larger ones with a central elongate and tapering spinelet, which appears to increase in proportional length towards the extremity of the ray. Within the area of the disk larger paxillæ are more frequently interspersed amongst the small ones, some of them with eight or nine spinelets surrounding the larger central one. The spinelets throughout are small and delicate. No pedicellariæ are present on the abactinal surface.

The supero-marginal plates, thirty to thirty-two in number from the median interradial line to the extremity, form a narrow and inconspicuous border when viewed from

above; the breadth of the plates is less than the length or height; and they form a well-rounded lateral wall to the rays and disk. Each plate bears a short, delicate, cylindrical and tapering spinelet, only a trifle more than a millimetre in length midway along the ray, placed on the abactinal side of the rounding and directed more or less upwards and at a slight angle outwards and aborally. The rest of the plate is covered with very small papilliform spinelets, of uniform size and widely spaced.

The infero-marginal plates are subequal in height to the companion series, with which they alternate rather than stand opposed; and their breadth on the actinal surface is greater than their length. Each plate bears a short, delicate lateral spine, similar to, but rather longer than, that on the supero-marginal series, directed horizontally and at a slight angle aborally. The longest measures about 1·75 mm.; and the length diminishes towards the extremity of the ray. On the inner half of the ray there is a second small spinelet, half the length and size of the lateral spine, standing close behind it in the median line, and occasionally another still smaller. On the outer part of the ray these small spinelets do not appear to be developed; and even on the inner part of the ray, plates occur in which they are scarcely distinguishable from the general miliary spinulation of the plate. This consists of minute, slightly tapering, thorn-like spinelets, of uniform size and widely spaced.

The adambulacral plates have an acute angular projection into the furrow; their breadth is greater than their length; and successive plates are rather widely separate, with the intervening space filled by ligament. The armature consists of:—(1.) A furrow series of seven to nine short, delicate, tapering spinelets; the median one, which occupies the apex or point of the angular projection, is the longest, and the others decrease as they recede from it on each side. (2.) A superficial series on the actinal surface of the plate, consisting usually of two, and occasionally three, short tapering spinelets, one longer and more robust than the others. These stand in a slightly oblique line, transverse to the direction of the ray. In small specimens and on the outer part of the ray the second and third spinelet may be greatly reduced in size or aborted altogether, but usually a representative miliary is present. One to three very small miliary spinelets may also stand on the actinal surface of the plate along its adoral margin, forming an apparent continuation of the furrow series; and occasionally one on the aboral margin, likewise in series with the marginal spinelets; and, more rarely, one on the outer margin behind the actinal spines. No other spinelets are present on the plate.

The mouth-plates are broad and the united pair convex and subtubercular, with a wide semicircular free margin. Each plate bears seven small mouth-spines, the innermost longest and most robust, the rest diminishing in size step by step as they recede from it. The innermost spine of each plate is directed horizontally over the buccal membrane parallel to the median interradial line, each succeeding spine radiating slightly more outward, the small outermost spines of the series having also a slightly downward trend. On the actinal surface of each plate there is a lineal series of four to six small spinelets running

parallel to the median suture, which decrease in size as they proceed outward; and between this series and the outer margin stand two small secondary spines, or sometimes only one, accompanied by one or two miliary spines; the secondary spines are, however, so small that they are scarcely distinguishable from the rest of the spinulation.

The actinal intermediate (ventral) plates are very few in number, not more than six to twelve in each area. They are small and convex, and bear two or three small tapering thorn-like miliary spinelets on their midst. They do not separate more than the innermost three or four adambulacral plates from the infero-marginal plates.

The anal aperture is subcentral and often difficult to see, but its position is usually indicated by the crowded circlet of paxillæ around it, although these differ in no way from the rest.

The papularium at the base of each ray is small and compact, probably with not more than six to nine papulæ in each, and often, I believe, with a less number; but this is difficult to ascertain without dissection. The size of the papulæ varies considerably in one and the same papularium, one or two being often much larger than the others.

The madreporiform body, which is small, oval, and subtubercular, is situated about midway between the centre and the margin, but rather nearer the latter. Its surface is marked with deep, coarse, convoluted furrows, which usually have the appearance of traversing the plate rather than of radiating from the centre to the margin; and there is frequently a large paxilla on its adcentral side.

Colour in alcohol, a dirty yellowish ashy grey.

Individual Variation.—This species is on the whole very constant in character; the only variations of any moment, which I notice in a considerable number of examples all from one station, affect the relative size and robustness of the prominent or largest spinelets on the actinal surface of the adambulacral plates; and the degree of development of the small companion to the lateral spine on the infero-marginal plates. There is also sometimes a slight variation—diminution—in the size of the minute miliary thornlets or papillæ on the actinal intermediate and infero-marginal plates. It may also be remarked in some examples that there is a well-defined plate or paxilla much larger than any of the others midway between the centre of the disk and the margin in the median interradial line, and these are probably the representatives of the primary interradial (basal) plates.

Young Phase.—The smallest example of *Pontaster planeta* in the collection measures $R = 15{\cdot}5$ mm. and $r = 4{\cdot}5$ mm. It presents all the characters of the adult in an unmistakable way, and there would be no hesitation in referring it to the species even if intermediate stages of growth were wanting. The relative shortness of the radial dimension in proportion to the interradial may be noticed. There are sixteen supero-marginal plates between the terminal and the median interradial line. The terminal plate is large and broad, and deeply indented proximally in the median line.

The spinelets on the supero-marginal plates are extremely small. The large actinal spinelet on the adambulacral plates is robust and accompanied by a well-developed companion, and sometimes a smaller third spinelet is also present. At least two to four intermediate or ventral plates are present in the actinal interradial areas. The miliary spinulation on these and on the marginal plates is very small, widely spaced, and papilliform, giving little more than a subgranular appearance under a low magnification. The knob at the distal extremity of the tube-feet is very large.

Locality.—Station 311. Off western coast of South America, near the entrance to the Straits of Magellan, opposite Port Churruca. January 11, 1876. Lat. 52° 45′ 30″ S., long. 73° 46′ 0″ W. Depth 245 fathoms. Blue mud. Bottom temperature 46°·0 Fahr.; surface temperature 50°·0 Fahr.

Remarks.—This species is remarkable for its close resemblance to the northern *Pontaster tenuispinus*. It is, however, distinguished by its smaller disk, by its delicate spinulation, as well as by the character of its paxillæ, and of the adambulacral armature. The general habit is also much smaller.

3. *Pontaster hebitus*, n. sp. (Pl. VIII. figs. 1 and 2; Pl. XII. figs. 1 and 2).

Rays five. R = 103 mm.; r = 16 mm. R < 6·5 r. Breadth of the ray near the base, 15 mm. In another example, R = 100 mm.; r = 15 mm. Breadth of the ray near the base, 13·2 mm.

Rays elongate, comparatively robust and broad, but tapering continuously from the base to the extremity, the outer part being very attenuate. The expansion at the extreme base is very slight, which causes the disk to appear small, and the interbrachial arcs to be rather acutely rounded. Abactinal surface subplane and level over the disk, but sometimes arched along the ray. Actinal surface of disk slightly convex, sloping from the mouth-angles to the margin and slightly along the ray.

The paxillæ of the abactinal surface are small, crowded upon the disk, but rather more widely spaced along the rays. The larger ones are composed of eight to ten, and occasionally more, very small, short, papilliform spinelets, which form a circlet round a central spine; the latter is cylindrical and tapering, and though small and delicate is much longer than its surrounding papilliform series. Smaller paxillæ, composed of five to seven spinelets, or even a smaller number, are interspersed amongst the larger ones upon the disk, and are the rule along the ray; the central spinelet, however, of these is often only papilliform, and equal to the encircling series, and is often wanting.

The supero-marginal plates, sixty in number from the median interradial line to the extremity, form a narrow bevelled margin to the rays and disk. The plates are very low and their length is slightly greater than their breadth. Each plate bears a short, conical, and tolerably robust spinelet, often truncate at the tip, so placed that it stands on the

rounded margin of the ray and is directed outward at an angle of about 45° to the plane of the abactinal surface. The surface of the plate is entirely covered with small, equal, papilliform granules, or minute stunted clavate spinelets; and occasionally one or two immediately below the conical spine are longer, more definitely spine-like, and tapering.

The infero-marginal plates alternate with the superior series, and both their height and their breadth are greater than their length. Each plate bears a short, robust, conical but often truncate lateral spine, which is, however, longer and more robust than the spine on the supero-marginal plates; and this is followed by two or three, or even more, smaller tapering and pointed spinelets; the character of the whole spinulation along the median part of the plate being definitely spine-like, the spinelets decreasing in size as they recede from the lateral spine and approach the inner end of the plate; two or sometimes three irregular series may be frequently defined, one series, however, being larger than the others. The rest of the surface of the plate is covered with small papilliform spinelets, which become more crowded, delicate, and cilia-like along the margins of the transverse sutures.

The adambulacral plates are broad and form prominent angular projections into the furrow. Their armature consists of:—(1.) A furrow series of six or seven rather elongate spinelets, rather robust at the base, tapering and sharply pointed; the median spinelet is the longest, and all radiate apart. (2.) On the surface of the plate is an obliquely transverse series of two or three robust conical spinelets, rather longer than any of the furrow series, the outer one being longest when two are present, and the middle one when there are three; on each side of these are two or three small spinelets near the margins of the plate.

The mouth-plates are large, convex, and subtubercular; and their surface is covered with short, conical, pointed spinelets, which decrease slightly in size as they recede from the mouth, but no definite order of disposition can be made out, and the mouth-plates have consequently a remarkably echinulate appearance. The true mouth-spines consist of a marginal series of about nine tapering, pointed spinelets on each plate, the two innermost being fully twice as long and robust as the others, and slightly compressed. There are thus four powerful mouth-spines at each angle guarding the actinostome; and two or three of the superficial spines immediately behind these are equally robust.

The actinal interradial areas are of very small dimensions, and the intermediate or ventral plates are few in number and do not extend beyond the fourth or fifth adambulacral plate. The separate plates are indistinguishable in spirit specimens, and their surface is covered with small, conical, and pointed spinelets.

The anal aperture is central and distinct, often surrounded by larger spinelets.

The madreporiform body is large, oval, and slightly convex, the inner end of the plate being about midway between the centre of the disk and the margin. Its surface is furrowed with numerous fine and deeply cut striations; many sharply bent and con-

voluted, their general disposition having the appearance of radiating from a central point. A number of the larger paxillæ surround the margin of the madreporite.

The papulæ are confined to an oval or pyriform area at the base of each ray ; they are of small size, and probably from forty to fifty are contained in each papularium.

Colour in alcohol, a bleached yellowish ashy white, frequently with a pinkish shade on the abactinal paxillar area.

Locality.—Station 49. South of Halifax, Nova Scotia. May 20, 1873. Lat. 43° 3′ 0″ N., long. 63° 39′ 0″ W. Depth 85 fathoms. Gravel, stones. Bottom temperature 35°·0 Fahr. ; surface temperature 40°·5 Fahr.

Remarks.—This species is nearly related to *Pontaster tenuispinus*, but presents a number of differences whose constancy and character appear to justify the recognition of the form as a distinct species rather than as a mere locational variety. When compared with *Pontaster tenuispinus*, *Pontaster hebitus* is distinguished by the comparatively small disk ; by the rays being generally broader throughout and devoid of any rapid expansion at the base ; by the greater breadth of the supero-marginal plates on the abactinal surface ; by the robust but short and truncate spines on the marginal and adambulacral plates ; by the character of the armature of the adambulacral plates, and by the total absence therefrom of the two-jawed pedicellariæ. The paxillæ of the disk-area are smaller than in examples of *Pontaster tenuispinus* of the same dimensions, and the general habit of *Pontaster hebitus* is larger and much more robust. Notwithstanding these differences, it is unquestionable that the species are very closely allied, and are most probably representative forms derived directly from a common ancestry.

4. *Pontaster limbatus*, n. sp. (Pl. VI. figs. 3 and 4 ; Pl. VII. figs. 1 and 2).

Rays five. R = 59 mm. ; r = 11·5 mm. R > 5 r. Breadth of a ray between the second and third supero-marginal plates, 10 mm. A larger example measures R = 73 mm. ; r = 13·25 mm. Breadth at the same place, 12 mm.

Rays moderately elongate, tapering gradually and regularly from the base, which is broad, to a finely pointed and attenuate extremity. Disk small. Interbrachial arcs wide but rather angular. Lateral walls high and vertical. Marginal plates forming a broad and slightly raised border on the abactinal surface. Abactinal surface of disk and rays flat. Actinal surface slightly convex on the disk, and more so along the rays, which have the appearance of being well rounded at the margins.

The paxillæ of the abactinal surface are rather small and distinctly spaced, but do not diminish in size along the rays so much as in *Pontaster tenuispinus*, and consequently appear larger than in that form. The larger paxillæ on the disk are composed of very small, short, papilliform spinelets, which usually take the form of a more or less compact group, rather than of a circlet surrounding the tabulum. Very few of the paxillæ on the

disk have a delicate elongate central spinelet, and these are chiefly in the region of the papularia; along the rays, however, the occurrence of the central spinelet is more frequent. No order is traceable in the arrangement of the paxillæ. No pedicellariæ are present on the abactinal surface, nor elsewhere on this species.

The marginal plates form a broad and slightly raised border to the disk and rays, the breadth of which diminishes gradually towards the extremity of the rays. The supero-marginal plates are thirty-nine in number (forty-four in the largest example) from the median interradial line to the extremity. Their breadth is greater than their length. The breadth of the paxillar area midway on the ray is only equal to, or very little greater than, the breadth of the supero-marginal plates. The height is greater than the length in the innermost plates of the ray, but rapidly diminishes, being subequal along the greater part of the ray, and less than the length near the extremity. Each supero-marginal plate, excepting the first on each side of the median interradial line, bears a single very small conical-pointed spine, which stands on the middle of the rounded angle of the plate. The longest of these spines is not more than 1·75 mm. in length, and they diminish in size as they proceed outwards, becoming mere microscopic thornlets on the outer part of the ray. The surface of the plates is slightly tumid, emphasising the divisional sutures, the direction of which is slightly oblique, trending from within outwards towards the base. The surface of the plates is covered with very minute subpapilliform spinelets, widely spaced.

The infero-marginal plates correspond to the superior series, and on the inner part of the ray the two series alternate instead of being directly superposed. Each plate bears a single short, robust, tapering lateral spine, the longest about 2·5 mm. in length, and decreasing in length on the outer part of the ray. The surface of the plate is covered with small, short, papilliform but slightly tapering thornlets, well spaced, which become more spiniform as they approach the lateral spine, the two or three immediately below this being longer than any of the others, but still none long enough to be ranked as a companion lateral spine.

The adambulacral plates have a prominent angular projection towards the furrow. Their armature consists of:—(1.) A furrow series of six or seven rather elongate, cylindrical, tapering spinelets, the median one longest, and all radiating apart. In consequence of the straight sides of the angular projection of the adambulacral plate the furrow series of spines have more or less the appearance of being divided into two sets which radiate apart. (2.) On the actinal surface of the plate are two robust tapering spines, and occasionally three on the inner part of the ray, forming an oblique series, the median spine being longest when three are present, and this is usually equal to or longer than the longest of the furrow series. On the aboral side of this oblique series and on the actinal surface of the plate are usually two small delicate spinelets which appear to form with more or less regularity a secondary series parallel to the larger one. On the adoral margin of

the plate are two or three small thornlets simulating more or less a continuation of the furrow series. There may also be one or two on the aboral margin, and these are close to the end next the furrow.

The mouth-plates, which are large, broad, and convex, have a very echinulate character, their surface being covered with numerous robust conical spinelets, sometimes forming two or three more or less irregular series parallel to the median suture, but more frequently without any definite order of arrangement. The marginal series consists of nine or ten short, cylindrical, very slightly tapering spinelets on each plate, the two innermost on each plate being equal and a little longer and more robust than the others, which are fairly subequal until near the aboral end of the series.

The actinal interradial areas are very small and with very few plates, probably not more than eight or ten being present. The pair of intermediate plates adjacent to the mouth-plates are much larger than any of the others, and are slightly tumid, which gives them rather a characteristic appearance. All are covered with tolerably numerous short, delicate, tapering spinelets.

The anal aperture is subcentral and rather difficult to distinguish, and there is no modification in the form or size of the surrounding paxillæ as compared with the other paxillæ in that region of the disk.

The madreporiform body, which is small, circular, and convex, is situated nearly, but not quite, midway between the centre and the extreme margin, being a little nearer the latter. Its surface is grooved with numerous rather coarse striations, which radiate centrifugally. There is usually a large paxilla on the adcentral side of the madreporite, and several other large paxillæ surround the margin.

The papulæ are confined to a comparatively large but elongate and pyriform area or papularium at the base of the rays. In the largest example there are four rows of pores, and the two inner ones are the longest and have larger pores, about nine in number in each. In the two outer rows there are not more than four or five pores. The whole number in a large papularium may thus be estimated at from twenty-five to thirty, and it occupies an area of about 6 mm. in length by 2 in breadth, or slightly more. In some examples the papulæ are all extended and appear to be of considerable length—measuring 2 to 3 mm. in a small specimen, and are delicate and tapering.

Colour in alcohol, a bleached ashy grey, with a slight brownish shade over the paxillar area of the disk.

Individual Variation.—So far as I am able to judge from the small series of specimens, the species appears to be remarkably constant in character, the only feature which seems to show a little variability being the spinulation of the infero-marginal plates: the spinelets below the lateral spine being more strongly developed in some cases than in others, and in some there appear to be incipient traces of a tendency to form a median series of spinelets larger than the rest, traversing the major dimension of the plate.

Localities.—"Porcupine" Expedition:

Off Valentia. Depth 100 to 150 fathoms.

Station 51 ("Porcupine," 1869). In the Faeröe Channel. Lat. 60° 6′ N., long. 8° 14′ W. Depth 440 fathoms. Bottom temperature 5°·5 C.; surface temperature 10°·9 C. (A single badly preserved specimen, which I refer with some doubt to this species.)

Station 2 ("Porcupine," 1870). South-west of the Scilly Islands. Lat. 48° 37′ N., long. 10° 9′ W. Depth 305 fathoms. Bottom temperature 14°·8 C.; surface temperature 16°·2 C.

Remarks.—This species is in many respects a near ally of *Pontaster tenuispinus*, but is readily distinguished by the small disk, by the short and regularly tapering rays, and by the broad border of the supero-marginal plates on the abactinal surface. It is further distinguished by the character of the paxillæ, by the remarkably small spines on the supero-marginal plates, by the short and solitary lateral spines on the infero-marginal plates, by the character of the armature of the adambulacral plates, and by the absence of pedicellariæ therefrom. The papularia and also the actinal interradial areas are different.

5. *Pontaster oxyacanthus*, n. sp. (Pl. IX. figs. 1 and 2; Pl. XII. figs. 7 and 8).

Rays five. $R = 73$ mm.; $r = 11$ mm. $R > 6{\cdot}5\,r$. Breadth of a ray near the base, 11 mm.

Rays elongate, tapering continuously from the base to the extremity, the outer part narrow and attenuate, and of great flexibility; the outer part in the specimen under notice curled round with an abactinal recurvature. Interbrachial arcs well-rounded. Abactinal surface plane. Actinal surface subplane. Lateral walls of the rays comparatively high and vertical.

The general paxillæ of the abactinal surface are comparatively small and simple, closely placed on the disk and inner part of the rays, but diminish greatly in size as they proceed outward, and are more widely spaced on the outer half of the ray. The crown consists of four to seven short, delicate, tapering spinelets, which radiate outward nearly horizontally, and appear to proceed almost from the centre of the tabulum. A few have a small central spinelet, more elongate and robust than the surrounding series. Upon the disk and at the extreme base of the rays a number of larger and specially-armed paxillæ are distributed amongst the general paxillæ above described. Each of these bears an elongate conical, tapering, robust, vertical spinelet, surrounded at the base by a ruff-like collarette of twenty or more minute ciliary thornlets. The central spine is powerful, and may measure 2 to 3 mm., but the length decreases as the paxillæ recede from the centre of the disk. The disposition of these armed paxillæ is somewhat irregular; they are, however, confined to a median radial area, and two or perhaps three irregularly

defined longitudinal lines may be distinguished; their presence amongst the small and comparatively inconspicuous general paxillæ of the abactinal surface forms a striking feature in the species.

The supero-marginal plates, thirty-eight in number from the interradial line to the extremity, form a well-defined though rather narrow border to the rays. The breadth, height, and length are about subequal, the last dimension being slightly in excess, and the plates are slightly convex and subtubercular abactinally. Each plate bears a robust, conical, tapering spine, about 4 mm. in length midway along the ray, directed perpendicularly to the abactinal plane of the ray. These spines diminish a trifle in length as they approach the base of the ray, but increase in robustness; whilst they decrease both in length and robustness on the outer part of the ray. On the outer side of this spine is usually a smaller and more delicate spinelet directed outward at an angle of about 45°, and occasionally two may be present, and sometimes they are little more than elongate miliary spinelets. The rest of the plate is covered with numerous very short, delicate, pointed miliary thornlets.

The infero-marginal plates alternate with the superior series, and their dimensions are subequal. Each plate bears three robust, conical, tapering, pointed spines, similar to those on the supero-marginal plates. These spines form a series along the median transverse line of the plate; the outermost or lateral spine is the longest, and slightly greater than the supero-marginal spine; the innermost spine of the three is the smallest, and is about half the length of the lateral one. The longest lateral spine is the third or fourth from the interradial line, and measures about 5 mm., and the succeeding ones decrease slightly in length as they proceed outward. The rest of the plate bears a few widely spaced, small, miliary thornlets, some of which at the base of the large spines are more elongate than the others. There is a naked suture-line between each plate.

The adambulacral plates are slightly longer than broad, and with only a slightly convex margin towards the furrow. Their armature consists of:—(1.) A furrow series of six short, rather thick, cylindrical, obtusely pointed spinelets, the inner pair slightly longer, and the outer one at each extremity very much smaller, than the rest; their posture resembles that of the fingers of a hand held slightly concave. (2.) On the actinal surface of the plate are two robust, slightly tapering but obtusely pointed spinelets, one behind the other in the transverse median line. The innermost stands close behind the marginal series, the outermost is slightly larger and is subequal in size to the innermost of the three spines on the infero-marginal plate. Two or three minute miliary spinelets may be present on the outer margin of the plate, but the rest of the plate has a naked appearance, and is only covered with membrane.

The mouth-plates are powerful and slightly convex; each plate of the united pair bears on its free margin six mouth-spines, the innermost being the longest, most robust, and slightly compressed; the others decrease as they recede from the mouth and become

very short. On the actinal surface of each plate are three robust, tapering, secondary mouth-spines, two placed so that a line joining them would run parallel to the median suture, and this line is continued on the outer part of the plate by one or two smaller spinelets. The third large spinelet is placed opposite the interspace between the two large spinelets above mentioned, midway between them and the outermost of the marginal mouth-spines.

The actinal interradial areas are very small, not more than eight to ten intermediate plates being present in each. The two innermost may bear a small central conical spinelet surrounded by a few minute miliary thornlets only. There are three complex pedicellarian apparatus in each area, situated in the lateral sutures which separate the two innermost intermediate or ventral plates; these organs consist of an oval cavity equally scooped out of the margins of the two adjacent plates, each margin beset with about five short, compressed, pointed, "dog-tooth" shaped spinelets, directed over the cavity, and frequently turned upwards into the same. The major axis of the cavity measures about 1 mm. There are also structures which I take to be very minute pedicellariæ present on a number of the adambulacral plates, appearing to protrude through the membrane, usually on the outer part of the adoral margin.

The anal aperture is subcentral and distinct, its margin being surrounded by a close circlet of small spinelets longer than the small spinulation of the paxillæ. At a little distance from the aperture is a circlet of the large armed paxillæ, standing more or less regularly in the radial and interradial lines.

The papulæ, though confined to the base of each ray, occupy a much greater area than in the other members of the genus, and are probably not comprised in a specially constituted papularium. They are small and widely spaced, more than fifty may be counted in each area, and isolated ones extend as far as the fourth marginal plate.

The madreporiform body, which is small, circular, and convex, is situated close to the marginal plates, and its surface is striated with rather fine convoluted furrows. One of the large powerfully spined paxillæ stands on its adcentral side.

Colour in alcohol, a bleached ashy white.

Locality.—Station 232. South of Yeddo (Japan). May 12, 1875. Lat. 35° 11′ 0″ N., long. 139° 28′ 0″ E. Depth 345 fathoms. Green mud. Bottom temperature 41°·1 Fahr.; surface temperature 64°·2 Fahr.

Remarks.—This is, perhaps, the handsomest species in the genus, at any rate the most striking, and is at the same time remarkably well characterised. Without referring to minor points of difference, it will suffice to say that the form is at once distinguished from all others by the group of large conical spines on the abactinal area of the disk, and by the presence of more than one large spine arranged in transverse series on the inferomarginal plates. Even without these striking features, *Pontaster oxyacanthus* would be well marked.

6. *Pontaster teres*, n. sp. (Pl. IX. figs. 5 and 6; Pl. XII. figs. 11 and 12).

Rays five. R = 42 mm.; $r = 7{\cdot}5$ mm. $R > 5{\cdot}5\,r$. Breadth of the ray at the base, 8 mm.

Rays elongate, narrow, subdepressed; not very broad at the base, tapering throughout up to the extremity. Interbrachial arcs well-rounded. Abactinal surface subplane, sloping slightly from the centre of the disk to the extremity of the rays. Actinal surface flat and level.

The paxillæ of the abactinal surface are large, ornate, and uniform, but decrease in size as they proceed along the ray. The large ones on the disk have a broad tabulum, bearing a double circlet of short papilliform spinelets, surrounding a central, robust, subconical, obtusely pointed spinelet, three or four times their length and thickness. There may be sixteen or even more spinelets in the outer circlet and about half that number in the inner circlet, which are slightly more robust, often subconical, and sometimes appearing subgranuliform, sometimes disposed so as to give the appearance of several larger central spinelets, one of which, however, is usually longer than the rest. On the outer half of the ray, only the outer circlet of papilliform spinelets is usually present, with a smaller number of spinelets, which are very short, obtuse, and subgranuliform in appearance. The embryonic basals, though quite inconspicuous, may be traced; their paxillæ being rather larger than the rest.

The supero-marginal plates, twenty-seven in number from the interradial line to the extremity, form a comparatively broad, but roundly bevelled margin to the rays when viewed from above. On the inner half of the ray the breadth is greater than the length, but towards the extremity the proportions are reversed. The plates are slightly convex, and the transverse sutures between them are very oblique, passing from within outwards adorally; the obliquity increases on the outer part of the ray, and the plates there have an oval appearance in consequence of their convexity and increased length. The surface of the plates is covered with numerous very short, subtapering or obtusely conical, papilliform thornlets, those on the centre of the plate, especially near the inner abactinal margin, being coarser than the rest. Most of the plates bear a single, delicate, tapering spinelet about 1 to 1·5 mm. in length. Perhaps normally all were thus armed, but many are absent in the specimens under notice, in one case apparently due to abrasion.

The infero-marginal plates alternate with the superior series. They are as high as, or even higher than, broad on the inner half of the ray. Their whole surface is covered with numerous closely placed, cylindrical or subclavate, delicate spinelets, which, though very minute, are much longer than those covering the supero-marginal plates. Each plate bears a delicate, tapering, sharply pointed lateral spine, the longest a little longer than 3 mm., and behind this normally one, or occasionally two, similar but smaller spinelets.

The adambulacral plates have an extensive acute angular projection into the furrow, which causes them to have a very broad appearance. Their armature consists of:—(1.) A

furrow series of ten to twelve small, delicate, cylindrical spinelets, their delicacy giving them an elongate appearance. These are situated on the margin of the angular projection, and radiate slightly apart, the length of the spines diminishing as they recede from the apex of the angle. Two or three still smaller spines form a continuation of the marginal series on each side on the surface of the plate. (2.) On the actinal surface of the plate are a number of small spinelets, similar in size and character to the furrow series. An oblique line of three to five, running subparallel to the adoral side of the angular prominence, is nearly always definitely formed, and sometimes a second line of fewer spines is discernible, converging towards the inner extremity of this line, with sometimes one or more spines in the included area, but usually the spines additional to the oblique line first mentioned are more or less grouped and irregular in their disposition. All these spines diminish in length as they recede from the furrow. Several of the adambulacral plates on the inner half of the ray bear at their junction with the marginal plates one of the large pedicellarian apparatus about to be described presently.

The mouth-plates are broad and conspicuous, but only slightly convex. The inner free margin of the united pair is subcircular in outline or even subparaboloid. The armature consists of ten small, slightly compressed, obtusely rounded spinelets, on each plate. The innermost one is much the longest and most robust, and is abruptly pointed; the other spinelets decrease as they recede from the mouth. There is consequently a pair of larger mouth-spines at each mouth-angle directed horizontally over the actinostome parallel to one another, the five pairs meeting at the centre of the orifice. The actinal surface of the plate is covered with a number of very small, uniform, delicate, thornlike papilliform spinelets, rather widely spaced, amongst which no order of arrangement is distinguishable.

The actinal intermediate (ventral) plates are not more than eight to ten in number in each interradial area, and they bear a peculiar pedicellarian apparatus. This is situated on the suture between two laterally adjacent plates, and consists of five or six short tapering compressed spinelets borne on each plate on the margin of a semicircular cavity, over which they are directed so as to meet and interlock at their tips with the corresponding series of the neighbouring plate. The outline of the apparatus is suboval, and the cavity contains in most cases a pulpy mass, probably foreign matter. There are five of the organs in each of the interradial areas, the median one and the next adjacent on each side being the largest; and from three to six similar organs may be present on isolated adambulacral plates on each side of a ray, as noticed above. A few pseudo-pedicellariæ of similar appearance, formed by the modified spinelets of adjacent paxillæ, occur occasionally on the paxillar area of the abactinal surface.

The anal aperture is subcentral and distinct, and surrounded by a circlet of slightly larger spinelets.

The papulæ are confined to a limited area at the base of each ray, but I am unable to

state the number present in each papularium on account of the size and propinquity of the paxillæ; and no superficial character is noticeable to indicate their extent.

The madreporiform body, which is small, subcircular or oval, and scarcely convex, is situated midway between the centre and the margin. Its surface is furrowed by coarse striations, of which only a few are convoluted, and the general direction of the grooves traverses the plate. Three sides are bounded by large paxillæ, that on the adcentral side being largest.

Colour in alcohol, a greyish white.

Young Phase.—A small example, having the dimensions of R=16 mm. and r=3·7 mm., may be recognised unmistakably as belonging to this species. Indeed, so clearly does this juvenile present the characters of the mature stage that very little need be said about it, except to place on record the early age at which in this genus the specific features are assumed. In the example under notice there are eighteen supero-marginal plates between the median interradial line and the terminal plate. The paxillæ of the abactinal area are large and well-developed, but with seldom more than a single circlet of spinelets surrounding the central one, which is proportionately large and robust. Traces, however, of the additional series of spinelets, which are borne on the tabulum in the adult stage, are to be found here and there. The primary basal plates are large and distinct. In the actinal interradial areas there are not more than two or four intermediate plates, and the large and characteristic comb-formed pedicellariæ, which are such a notable feature in the adult, are not yet formed, excepting a single incipient one which is present in one area. The spinulation of the infero-marginal plates and the armature of the adambulacral plates have precisely the same character as in the adult. The acutely-angular and far-reaching projection of the adambulacral plates into the furrow is especially to be remarked, and the oblique lineal series of three to five spinelets on their actinal surface is fully characterised. The mouth-plates are broad and convex, and their armature well-developed.

Locality.—Station 192. In the Banda Sea, between the Ki Islands and Banda Islands. September 26, 1874. Lat. 5° 49′ 15″ S., long. 132° 14′ 15″ E. Depth 140 fathoms. Blue mud. Surface temperature 82°·0 Fahr.

Remarks.—This species is readily distinguished by the character of the adambulacral armature, as well as by the posture and spinulation of the marginal plates, and the character of the paxillæ of the abactinal area. I know of no other form with which it can be confounded.

7. *Pontaster forcipatus*, n. sp. (Pl. VIII. figs. 3 and 4; Pl. XII. figs. 3 and 4).

Rays five. R = 59 mm.; r = 11 mm. R < 5·5 r. Breadth of a ray near the base, 9·5 mm.

Rays elongate, narrow, very slightly expanded at the base, tapering continuously up to the extremity. Interbrachial arcs widely rounded. Abactinal surface of disk and

rays flat and level. Actinal surface of disk very prominent at the mouth-angles, and sloping thence to the margin and along the rays.

The paxillæ of the abactinal area are moderately large, numerous, and usually well-defined, consisting of eight to twelve small, uniform, papillose spinelets, encircling a central, robust, more or less elongate, conical spinelet. Smaller paxillæ of three to five spinelets, and without a central conical spine, are interspersed occasionally amongst the larger paxillæ, and entirely occupy the outer part of the ray. Peculiar pedicellaria-like bodies formed of four or five flattened and modified spines are present here and there, most frequently along the margins of the abactinal area of the rays, where they form a more or less definite line close up to the marginal plates; and comparatively few are to be found upon the disk, excepting in the neighbourhood of the papular areas at the base of the rays.

The marginal plates are small, and confined to the side of the ray, to which they form a nearly vertical wall. The supero-marginal plates are about thirty in number from the median interradial line to the extremity; they are longer than high, and little more than the thickness of the plate is visible on the abactinal surface. Each supero-marginal plate bears on, or near, this upper margin a moderately long conical spine, robust at the base, tapering to a sharp point, and directed almost vertically. Two or three spines on each side of the median interradial line are very small, then follow the longest spines on the ray, and the series diminishes gradually towards the extremity. In consequence of the length of the supero-marginal plates the spines are rather widely spaced. The general spinulation of the plate consists of minute conical granules, widely spaced. Below the spine the plate is usually very sparsely granulated, and not unfrequently a more or less extensive naked area occurs at the base of the spine, only a few well-spaced conical granules being present at the sides of the plate near the suture, except in the interbrachial arc, where the granules invariably extend over the whole of the plate. One of the four-valved pedicellariæ may be present on the suture between the supero-marginal plates, and sometimes two or three, or more, occur in close succession in the interbrachial arc.

The infero-marginal plates correspond to the superior series, each bearing a similar and equal-sized conical spinelet, directed horizontally and placed opposite to the supero-marginal spine. On the inner portion of the ray there may be one or two small spines at the base of the lateral spine. The superficial spinulation of the infero-marginal plates consists of conical or papilliform granules similar to those on the superior series, and sometimes a similar naked or sparsely granulated area occurs below the spine. On the edge of these plates adjacent to the adambulacral plates are a series of pedicellariæ of the same form as those above described on the abactinal surface, but rather irregular in their disposition.

The adambulacral plates form an angular prominence into the furrow, and bear on their inner margin a semicircular comb of about seven short, equal-sized spines, which taper slightly, but are rather obtuse. External to these, on the actinal surface of the plate,

is one short, robust, conical spine. Excepting one or two isolated granules or miliary spinelets there are no other spinelets on the plates, though at first sight the pedicellariæ, which stand on the margin of the infero-marginal plates, might almost be considered to belong to the adambulacral plates.

The mouth-plates are large and rather prominent, and their armature consists of a marginal series of about seven to ten short spinelets, the two innermost being much the largest, whilst the others are subequal or decrease slightly in size as they recede from the mouth. On the actinal surface of the plate there is usually a lineal series of small conical spines running parallel to the suture, and in the interspace between these and the marginal series there are one or more spines, one of which is much larger than the others, and is the representative of the large spine on the actinal surface of the adambulacral plates. There is frequently some irregularity in the disposition of these inner spines.

The actinal interradial areas are small, and occupied only by a few irregularly placed intermediate plates; the spinelets they bear are most of them modified into pedicellariæ-like bodies similar to those elsewhere found on this species.

The anus is central and very distinct, with several larger spinelets surrounding its margin.

The madreporiform body is small but convex, and is usually less (but sometimes rather more) than its own diameter distant from the margin. The striæ are coarse and deeply incised.

The papular groups at the base of the rays are small and with not more than eight to ten papulæ in each. The paxillæ amongst the group are small and modified in form, and the crown is often represented only by the central spine.

Colour in alcohol, a bleached greyish or yellowish white.

Young Phase.—The smallest example (from Station 46) measures R = 11 mm., $r = 2{\cdot}5$ mm., and is already so far characterised that it is scarcely too much to say that it would be referred with but little hesitation to the species, even if found isolated. There are twelve supero-marginal plates, and the spines borne on these and the infero-marginal plates, though small, are tolerably robust in comparison to the size of the specimen. Robust central spinelets are already present on a number of the paxillæ, whilst the encircling series, five or six in number, are mere conical thornlets radiating apart. There are several large and fully developed pedicellariæ on the abactinal paxillar area; similar large valvate pedicellariæ, composed of four or five spines, are also present on the actinal surface, chiefly in the actinal interradial areas, but also on the infero-marginal plates, extending along the ray as far as the fourth or fifth plate, or occasionally further. There are two if not more small intermediate plates in the actinal interradial areas. The adambulacral plates have a furrow series of four or five spinelets, with or without an incipient thornlet at the end of the series, and on the actinal surface of the plates is a

much larger conical spinelet, and one or two or sometimes more thornlets. The miliary spinulation of the infero-marginal plates consists of sharp conical thornlike granules widely spaced. The mouth-plates have a marginal series of seven or eight spinelets, the innermost the longest, the rest very short and little more than flattened dog-tooth-shaped spinelets; there is also a lineal series of five or six small thornlets on the actinal surface of the plate, parallel to the median suture. The tube-feet have a large, thick, and somewhat flattened terminal knob.

Individual Variation.—This species is remarkably constant in its general characters, so much so that out of a large series of specimens from one locality (Station 46) I have scarcely noticed any features, even of trivial importance, that present differences worth mentioning, excepting, of course, the normal modifications attendant on age and growth. It may be remarked, however, after a careful examination of this material, that a slight variation occurs in the length and delicacy of the central spinelet of the paxillæ of the area of the disk; that occasionally one or two miliary spinelets below the large lateral spine on the infero-marginal plates are more strongly developed in some examples than in others; and that there is a slight variation in the length and robustness of the single large spine on the actinal surface of the adambulacral plates (in one example they are nearly as large as the spines on the marginal plates, and consequently very conspicuous). There is also to be observed in some specimens a short and delicate miliary spinelet on one or even sometimes on both sides of the actinal spine, but this is apparently of very rare occurrence, and the companion spinelets are indeed so small that their presence can scarcely be said to modify the "formula" of the adambulacral armature.

Locational Variation.—In a small series of specimens from Station 50 the rays appear to be proportionally rather narrower throughout when compared with examples of the same size from Station 46, and the interbrachial arc is consequently more distinctly rounded. The length of the major radius in proportion to that of the minor radius is also somewhat greater in the specimens from Station 50.

The few specimens from Stations 44 and 45 are of much larger habit than any of the others. The radius of the disk of the largest measures 15 mm., and the breadth of a ray near the base (between the second and third supero-marginal plates) is 12·5 mm.; unfortunately the tips of the rays are broken away in all these specimens. There is a short but robust conical secondary spinelet below the lateral spine on the infero-marginal plates on the inner half of the ray, and sometimes even a second is present, the disposition being then irregular. On the innermost two or three plates on each side of the median interradial line the true lateral spines are reduced to the size of secondaries. The miliary spinelets on the actinal surface of the adambulacral plates are usually more numerous and spiniform, and the one that stands beside the large actinal spine is sometimes well-developed.

Localities.—Station 44. Off the coast of North America, east of Delaware and Maryland.

May 2, 1873. Lat. 37° 25′ 0″ N., long. 71° 40′ 0″ W. Depth 1700 fathoms. Blue mud. Bottom temperature 36°·2 Fahr. ; surface temperature 56°·5 Fahr.

Station 45. Off the coast of North America, east of Delaware and Maryland. May 3, 1873. Lat. 38° 34′ 0″ N., long. 72° 10′ 0″ W. Depth 1240 fathoms. Blue mud. Bottom temperature 37°·2 Fahr. ; surface temperature 49°·5 Fahr.

Station 46. Off the coast of North America, east of New Jersey. May 6, 1873. Lat. 40° 17′ 0″ N., long. 66° 48′ 0″ W. Depth 1350 fathoms. Blue mud. Bottom temperature 37°·2 Fahr. ; surface temperature 40°·0 Fahr.

Station 50. South of Halifax, Nova Scotia. May 21, 1873. Lat. 42° 8′ 0″ N., long. 63° 39′ 0″ W. Depth 1250 fathoms. Blue mud. Bottom temperature 38°·0 Fahr. ; surface temperature 45°·0 Fahr.

Remarks.—The only form with which this species might be confused is *Pontaster mimicus;* the differences that separate them are discussed in detail under the head of that species. *Pontaster forcipatus* is readily distinguished from the other members of the genus by the narrow border of the supero-marginal plates, by the single large conical spine on the actinal surface of the adambulacral plates, and by the numerous characteristic pedicellariæ.

7*a*. *Pontaster forcipatus*, var. *echinata*, nov.

This variety, which is of large habit, is characterised by the great thickness of the spines on the marginal plates (which are rather more than 1 mm. thick at the base, and 4·5 mm. long), by the much larger size of the central spinelets on the paxillæ, and by the greater number of the paxillæ thus furnished. As compared with the typé the disk appears to be slightly smaller. There is usually a robust and well-developed secondary spinelet below the lateral spine on the infero-marginal plates, at least on the inner half of the ray ; but this is not always present, and the general spinulation of the infero-marginal plates is decidedly more echinulate. On the adambulacral plates there are seldom more than five spinelets on the actual furrow margin, but it is sometimes difficult to distinguish these from one or two minute thornlets at each end of the series, which stand at the adoral and aboral margins on the actinal surface of the plate. The actinal spine is very large and robust, and frequently slightly curved. The pedicellariæ are much less numerous, and are confined to the actinal interradial areas ; they are not present on the infero-marginal plates (or only very rarely), and consequently do not extend along the ray.

Young Phase.—A small example, which measures R = 17·5 mm. and $r = 3{\cdot}75$ mm., has fourteen supero-marginal plates. The lateral spinelets are longer and more delicate than in the type-form of the same size, and the disk appears relatively smaller. The character of the spinulation of the infero-marginal plates is more echinulate, and so also is that of the paxillæ. The slight imbrication of the supero-marginal plates is well seen ; the adoral

end of one plate lying upon the aboral end of the preceding plate. There are no pedicellariæ; whilst in the type-form at this, and even at an earlier, stage they are well-developed. There appear to be no actinal intermediate plates, or only the smallest rudiments in one area. There are not more than four spinelets on the actual furrow margin of the adambulacral plates directed over the furrow, but there is a similar spinelet at each extremity of the series, and directed parallel to the furrow. The mouth-plates have a marginal series of seven spinelets on each plate, the inner one being larger than the rest, and there is a large robust conical spine on the actinal surface of the plate, which is strongly developed and very conspicuous.

Locality.—Station 146. Between Marion Island and the Crozet Islands. December 29, 1873. Lat. 46° 46′ 0″ S., long. 45° 31′ 0″ E. Depth 1375 fathoms. Globigerina ooze. Bottom temperature 35°·6 Fahr.; surface temperature 43°·0 Fahr.

Remarks.—The close affinity of this form to its far distant type in the North Atlantic is especially remarkable, whilst the manner in which some of its characters approach even more nearly those of *Pontaster mimicus* from the North-Australian Sea are very striking, and at the same time highly suggestive of the genetic connection of the three forms.

8. *Pontaster mimicus*, n. sp. (Pl. VI. figs. 1 and 2; Pl. VII. figs. 5 and 6).

Rays five. R = 78 mm.; $r = 10{\cdot}5$ mm. $R = 7{\cdot}5\ r$. Breadth of a ray between the second and third supero-marginal plates, 10 mm.

Rays elongate, tolerably robust at the base, tapering continuously to a finely pointed extremity, having a more or less rounded character laterally and especially on the actinal surface. Abactinal surface plane, or slightly carinate along the rays. Interbrachial arcs rather acutely rounded. Lateral walls high at the summit of the arc, and at the base of the rays. Actinal surface of the disk subplane and not prominent at the mouth-angles; rounded at the margins.

The paxillæ of the abactinal area are rather small and distinctly spaced. The largest, which are on the disk, have a crown of twelve to twenty very small, low, rounded spinelets, which appear only like granules when viewed from above, surrounding a proportionally long, delicate, tapering central spine. The presence of these spinelets imparts quite a hairy or subpapillose appearance to the abactinal area of the disk when viewed with the naked eye, the individual paxillæ and the small granuliform spinelets being invisible. Smaller paxillæ formed of three to six granuliform spinelets, and without a large elongate one, are interspersed amongst the larger paxillæ on the disk. The paxillæ at the margins of the disk and along the whole length of the ray are very small, and central spinelets are only present on some of those along the median radial region. No definite order is discernible in the arrangement of the paxillæ.

The supero-marginal plates are confined entirely to the lateral wall of the ray, only

their upper edge being visible on the abactinal surface, to which, however, they form a narrow and slightly raised border. The supero-marginal plates are thirty-three in number from the median interradial line to the extremity. Their length is greater than their height throughout, except the innermost on each side of the median interradial line; and midway along the ray they have the form of elongate, suboval, imbricating squamiform plates. Each plate bears a robust conical spine, very thick at the base, and tapering to a sharp point—the longest, which is about the fifth from the base, measuring 4 mm. or a trifle more,—borne on a distinct articulatory tubercle near the upper margin of the plate. On the innermost plate, on each side of the median line, the spine is reduced to the size of a secondary. On the surface of the plates are a few minute, conical granules, very widely spaced, which appear to be generally confined to the adoral and aboral ends of the plate, the area of the plate below the spine being generally nearly, if not quite, naked.

The infero-marginal plates correspond to the superior series, but these are not exactly superposed, and the line of suture forms two unequal facets. Each plate bears a robust, tapering, sharply-pointed lateral spine, similar in form and character to the supero-marginal spine, the longest (which is about the eighth or ninth) measuring 4·5 mm. Midway on the surface of the plate, between the base of this spine and the margin adjacent to the adambulacral plates, is a small, conical, secondary spine, broad at the base and sharply pointed; and the miliary spinulation of the plate consists of very minute, conical, or papilliform granules, scarcely worthy of being called spinelets, but still rather too long to be described as granules. Very few are present on the median area of the plate below the lateral spine, which is usually almost, if not quite, naked. As seen in the actinal view, the breadth of the infero-marginal plates is about equal to their length at the base of the ray, but at the fifth or sixth plate the length becomes the greater dimension.

The adambulacral plates are elongate, with a prominent and well-rounded semicircular margin towards the furrow. Their armature consists of:—(1.) A furrow series of six or seven short, cylindrical spinelets, the outermost at each end of the series being much shorter than the others; and there are two or three equally small or smaller papilliform spinelets on the adoral and aboral margins of the plate on the actinal surface, forming as it were a continuation of the furrow series. (2.) On the midst of the actinal surface is one large but short, robust, conical spine, with usually a minute papilliform miliary near it on the adoral side and close to the outer margin of the plate.

The mouth-plates are large, and the united pair have a nearly circular outline, and are convex actinally. Their armature consists of six small tapering spines on each plate, the innermost one being much larger and fully one-third longer than the others, which diminish in size as they recede from the mouth, the last being very small. They are rather widely spaced, and radiate apart regularly. On the actinal surface of the plates is a regular lineal series of about eight small spines placed parallel to the median suture; and in

the interspace between these and the margin of the plate is one large robust conical spine similar to those on the adambulacral plates; there may also be two or three irregularly placed small conical thornlets on the outer part.

The actinal interradial areas, which are of small dimensions and very narrow, do not extend beyond the third infero-marginal plate. They are slightly sunken, especially between the mouth-plates and innermost marginal plates, which emphasises the convexity of the former and contributes to the ornate character of the actinal aspect of the disk. The areas are occupied by a small number of rather large intermediate plates, which bear upon their surface a few small, pointed, thorn-like spinelets. There are five or six pedicellariæ in each area, composed of four or five modified spines similar to those in *Pontaster forcipatus*.

The anal aperture is subcentral, large and distinct.

The papularia are small, compact, and very conspicuous, their area being a prominently convex oval. They are situated on the disk, with their outer extremity touching a line drawn across the base of the ray, and contain about a dozen papulæ in each, the calcareous divisions between them being narrow, and forming a net-like structure.

The madreporiform body is small, oval, slightly convex, and situated about, or rather more than, its own diameter distant from the inner edge of the marginal plates. The striation-furrows with which its surface is grooved are rather coarse, and are more or less irregular in their radiation. Several large paxillæ stand near the margin of the madreporite.

Colour in alcohol, an ashy white; almost a bleached white on the actinal surface.

Locality.—Station 191. In the Arafura Sea, north-west of the Arrou Islands. September 23, 1874. Lat. 5° 41′ 0″ S., long. 134° 4′ 30″ E. Depth 800 fathoms. Green mud. Bottom temperature 39°·5 Fahr.; surface temperature 82°·2 Fahr.

Remarks.—This species is remarkable for its close affinity to, and apparent mimicry of, *Pontaster forcipatus*. It is, however, distinguished from that form by the smaller disk, by the rounded character of the rays in the actinal aspect, by the different facies of the actinal surface and of the marginal plates, by the presence of the well-developed secondary spine on the infero-marginal plates, by the smallness and scarcity of the miliary granulation on the marginal plates generally, by the different habit of the paxillæ, by the general absence of pedicellariæ (excepting the few in the actinal interradial areas), by the greater prominence of the semicircular margin of the adambulacral plates, by the slightly different character of their armature, and also of that of the mouth-plates.

9. *Pontaster pristinus*, n. sp. (Pl. VI. figs. 5 and 6; Pl. VII. figs. 7 and 8).

There is a single small specimen, which, although in a young and immature stage of growth, presents characters which indicate that it does not belong to any of the species hitherto described. Under these circumstances I feel obliged to give it a new specific

name, although I take that step with much reluctance, as the state of preservation and the juvenile condition of the example do not permit of a complete or even satisfactory diagnosis being written. The present remarks will therefore be offered in the form of a comparison of the available characters of the small asterid under notice with those of a young *Pontaster forcipatus* of the same size—the species to which it is most nearly allied. The measurements of the example under notice are R = 11·5 mm. (about), and $r = 3{\cdot}25$ mm.

The supero-marginal plates, which are fifteen or sixteen in number from the median interradial line to the extremity, are low and elongate, in fact their length is remarkable. They are confined entirely to the lateral wall of the ray; and bear centrally a large boss on which is articulated a conical pointed spine. The paxillæ of the abactinal area are especially noteworthy on account of the single long central spine, which upon the disk and at the base of the ray gives a more or less hirsute appearance. On this part of the area the central spinelet is surrounded by four or five minute papilliform granules; but along the ray the small isolated squamiform plates which represent paxillæ bear only the single long central spinelet. In *Pontaster forcipatus*, at even an earlier stage of growth, the squamous basement plates of the paxillæ are very much larger, and bear several low granuliform papillæ only, even up to the extremity of the ray,—the central spinelet when present being inconspicuous. The anal aperture is distinct and surrounded by large spinelets. The papularia are very conspicuous, having the form of a small well-defined convex elevation. There are no pedicellariæ present; in *Pontaster forcipatus*, on the other hand, these organs are large and well-developed even in much smaller examples. The spinelets on the terminal plate are large, comparatively long, and form a tuft-like group. The madreporiform body is large and well-developed, whilst in *Pontaster orcipatus* of the same size it is scarcely discernible.

The adambulacral plates are elongate, and bear four or five rather short, equal-sized spinelets on the furrow margin, the one at the aboral end of the series being removed from the rest, and radiating apart with a trend outwards and only partly over the furrow. There is a single comparatively large and sharply pointed spine on the actinal surface of the plate; and on the adoral margin within the disk-area there may be one or more very small thornlets, but elsewhere there are generally no other spinelets beyond those above mentioned on the plates. The mouth-plates do not appear to bear more than four or five spinelets in the marginal series, the innermost being much larger than the others; and on the actinal surface of the plates is one large conical spine, and one or more minute thornlets.

The infero-marginal plates are elongate and correspondent to the superior series, each bearing a single conical and pointed lateral spine, and a few small isolated spinelets near the adoral and aboral ends of the plates.

In the actinal interradial areas there are four intermediate or ventral plates which are comparatively large, and bear on their surface a few isolated conical thornlets. There is

no trace of the presence of any pedicellariæ whatever on the actinal surface, whilst in *Pontaster forcipatus* of this size, and even smaller, these organs form a most conspicuous feature, being already well developed in the smallest example I have examined. No pedicellariæ are to be found anywhere on *Pontaster pristinus*.

Notwithstanding the incompleteness of the above summary of the characters of this young starfish, they appear to me sufficient to show that we are dealing with a distinct species. The great depth at which it occurs (2650 fathoms) is worthy of note.

Colour in alcohol, a dirty ashy or slightly brownish grey.

Locality.—Station 325. Off the coast of South America, east of Buenos Ayres. March 2, 1876. Lat. 36° 44′ 0″ S., long. 46° 16′ 0″ W. Depth 2650 fathoms. Blue mud. Bottom temperature 32°·7 Fahr.; surface temperature 70°·8 Fahr.

10. *Pontaster venustus*, n. sp. (Pl. VIII. figs. 5 and 6; Pl. XII. figs. 5 and 6).

Rays five. $R = 37$ mm.; $r = 8$ mm. $R > 4{\cdot}5\,r$. Breadth of a ray near the base, 8·5 mm.

Rays elongate, rather broad at the base, and thence tapering continuously up to a finely pointed extremity. Interbrachial arcs well rounded. Abactinal surface of disk and rays flat, slightly sloping from the centre of the disk to the extremity of the rays. Actinal surface flat and level.

The paxillæ of the abactinal area are small and rather widely spaced, with a crown of five to eight small papilliform spinelets in those situated about midway between the centre and the extremity of the ray, and six to ten, or occasionally more, in those upon the disk. The larger paxillæ in the respective regions have frequently a single delicate, hairlike, central spinelet, longer than the diameter of the whole crown of the paxilla, and four or five times longer than the small papilliform spinelets that encircle it. No order of arrangement is presented by the paxillæ. No pedicellariæ of any kind are to be found on the abactinal area, or indeed anywhere upon this species.

The marginal plates are conspicuous in the abactinal view, and form a well-defined and slightly raised border to the disk and rays—the breadth, however, diminishing considerably towards the extremity of the rays. The supero-marginal plates are twenty-five or twenty-six in number from the median interradial line to the extremity. Their breadth at a little distance from the base of the ray is about equal to their height, and their length is rather greater than their breadth, often nearly one-third. Each supero-marginal plate, excepting the first on each side of the median interradial line, bears a single moderately-long conical pointed spine, standing on the middle of the rounded angle of the plate, and directed laterally and very slightly forwards at an angle of about 45° to the abactinal surface of the ray. These spines are robust at the base, and borne on a slight prominence. They increase in length up to the fifth plate from the median interradial line, where they measure 2·5 mm., and then decrease slowly and gradually up to the

extremity where they become quite microscopic. The rest of the plate is covered with very minute, uniform, thorn-like, or spiniform granules, widely spaced.

The infero-marginal plates are correspondent to the superior series, and similar in every respect; but they extend much further on the actinal surface than the superior series do on the abactinal surface, and are distinctly tumid in the actinal aspect; their breadth up to the middle of the ray is greater than their length, and on the inner part at least of the ray the two series alternate instead of being directly superposed. Each plate bears a single conical spine, similar to that on the supero-marginal series, directed horizontally and very slightly outwards. The fourth or fifth spine from the median interradial line is the longest, and measures about 3 mm.; outward from this the length diminishes gradually, but to a less degree than in the superior series; on the outer half of the ray they are consequently longer than the companion series, and are distinctly visible up to the extremity although very small—less than one millimetre in length at the tip. Midway between the lateral spine above described and the inner margin of the plate is a small spinelet similar in character but one third the size; this disappears, however, on the outer part of the ray. The rest of the plate is covered with minute, widely spaced, thorn-like spinelets, rather longer and more spine-like than the covering of the supero-marginal plates; but their isolation and paucity are remarkable.

The adambulacral plates form conspicuous semicircular or angular projections into the furrow. Their armature consists of:—(1.) A furrow series of six to eight small, cylindrical, slightly tapering, blunt or roundly pointed spinelets, the outer one on each side being much shorter than the rest. These spinelets are covered with a delicate tissue, and are arranged on the margin of the semicircular projection. When the furrow is contracted and the spines are directed vertically to the plane of the actinal surface, they form a subpalmate group with a more or less acute angle into the furrow; the opposite series on the two sides of the furrow touching one another, and entirely separating each pair of tube-feet from their neighbouring pairs. (2.) On the actinal surface of the plate is a single, robust, conical, and sharply-pointed spine similar in character to the lateral spines, and about half the length, and behind this are usually two or three small, short, thorn-like spinelets; but no other spinelets or granules are present on the plate.

The mouth-plates are large, tumid actinally, and the united pair are as broad as long. Each plate bears on its free margin an armature of seven spines, which increase in length as they proceed inwards, the innermost being twice the length of the outermost, which are not greater than the smallest spines of the adambulacral armature. The innermost pair stand parallel, and are directed towards the centre of the actinostome, the succeeding spines being parallel or only radiating very slightly at the outer part of the series. On the surface of the plates there are three small spinelets in a line with the median suture, the innermost the longest, and the outermost the smallest; and in the space between the outermost spine of this series and the free marginal series of spines is a tolerably robust, conical, and pointed spine longer than the rest, the representative of the

actinal spine on the adambulacral plates; and behind this, on the outer part of the plate, there are three or four minute, thorn-like spinelets, irregularly placed. The tumid character of the infero-marginal plates and of the mouth-plates give a very ornate appearance to the actinal aspect of this species.

The actinal intermediate plates are comparatively rather large, but not more than ten to twelve are present in each interradial area; they are slightly tumid, and bear near their centre three or four small thorn-like spinelets.

The anus is subcentral and very distinct, and a punctured tube is seen protruding; the surrounding paxillæ are not distinguishable in any way from the others in that region of the disk.

The papular groups at the base of the rays are small, with eight papulæ in each; these are arranged in two lateral series of three, with a medium series of two, which are larger and wider apart. The paxillæ between and in the neighbourhood of the papulæ are precisely similar to the others on the abactinal area.

The madreporiform body, which is small, circular, and slightly convex, is situated nearly midway between the centre and the extreme margin, but rather nearer the latter. Its surface is grooved with numerous comparatively fine, deeply incised, convoluted and radiating striations; and there is one large paxilla on its adcentral side larger than any of the others on the abactinal area.

Colour in alcohol, a bleached yellowish white.

Young Phase.—There is a young example (from Station 76) which measures R = 14 + mm. (the terminal plate being unfortunately broken from every ray), and $r = 3{\cdot}5$ mm. The paxillæ are remarkably large as compared with the size of the animal. The marginal plates are large and have the characters of the adult. Thirteen supero-marginal plates are present between the median interradial line and the broken extremity, and from this region, I believe, only the odd terminal plate is missing. The lateral spine on the infero-marginal plates is remarkably small and inconspicuous, and only a little larger than the rest of the spinulation of the plate; whilst the spine on the supero-marginal plate, though very small, is much more robust—an opposite proportion to what obtains in the adult stage. The adambulacral plates are large, elongate, and separated by wide interspaces occupied by ligament. The furrow series of spines has fully assumed the palmate character of the adult, and the single large spine on the actinal surface of the plate is remarkably robust. There are only four intermediate or ventral plates in each actinal interradial area, and the inner pair are much the largest, in fact larger than any of the adambulacral plates. On their surface are a few isolated thornlets. The actinal surface generally already shows traces of the tumid character of the plates, which forms at once an ornate and a distinguishing feature of the adult form.

Localities.—Station 76. Between the islands of San Miguel and Pico (Azores). July 3, 1873. Lat. 38° 11′ 0″ N., long. 27° 9′ 0″ W. Depth 900 fathoms. Pteropod ooze. Bottom temperature 40°·0 Fahr.; surface temperature 70°·0 Fahr.

Station 79.—Between the Azores and Madeira. July 11, 1873. Lat. 36° 21′ 0″ N., long. 23° 31′ 0″ W. Depth 2025 fathoms. Globigerina ooze. Bottom temperature 35°·9 Fahr.; surface temperature 71°·5 Fahr.

10*a*. *Pontaster venustus*, var. *robusta*, nov.

There is a single example of *Pontaster* dredged in the neighbourhood of the Cape Verde Islands, which I place, though with some hesitation, as a variety of this species. Although it accords with the general structural formula of the species just described, it has a remarkably well marked individuality; and until a further supply of material is available I propose to recognise it as a nominal variety of *Pontaster venustus*.

As compared with the type-form, the observer is at once struck with the massive character of the rays and the remarkable breadth of the border of marginal plates on the abactinal surface, which is nearly as great as the width of the paxillar area, midway between the centre and the extremity of the ray. The supero-marginal plates are very large and massive, and their breadth is greater than their length. The remaining features seem to be only differences of degree, and I do not therefore feel justified, on the scanty material of a single example, in ranking this as a separate species. Thus, the large spines on the marginal plates of both series are relatively shorter and more robust, and the small but definite spine below the lateral spine is either absent altogether or very greatly diminished. The spinelets which compose the paxillæ are longer and very delicate; and the spinelet on the actinal surface of the adambulacral plate is remarkably robust, short, and conical. In the example under notice there are twenty-five supero-marginal plates, counting from the median interradial line to the extremity; and the measurements are, R = 50 mm.; r = 10 mm. Breadth of the ray between the second and third supero-marginal plate, 10·5 mm.

Locality.—Off the Cape Verde Islands. There is no record of the position, depth, or conditions.

11. *Pontaster trullipes*, n. sp. (Pl. IX. figs. 3 and 4; Pl. XII. figs. 9 and 10).

Rays five. R = 27 mm.; r = 5·25 mm. R > 5r. Breadth of the ray at the base, 5–5·5 mm.

Rays elongate and narrow, tapering continuously up to the extremity, the outer part of the ray being moderately attenuate. Interbrachial arcs well rounded. Abactinal surface subplane, sloping slightly from the disk to the extremities of the rays. A slight tumidity present in the paxillar areas at the base of the rays in the neighbourhood of the papularium. Actinal surface flat and level.

The paxillæ of the abactinal surface are very small, simple, and well spaced. About

midway along the ray they consist of three, or rarely four, very short spinelets, whilst only one or two are frequent near the margin. On the central part of the disk, larger paxillæ occur, with five or six, or even more, spinelets. When more than five are present, one is usually central, but is uniform in length and size with the rest. In each interradial line, midway between the centre of the disk and the margin, is a conspicuous circular plate bearing twenty to thirty spinelets similar in all respects to those forming the paxillæ, of which in fact this may be considered as an enlarged example. These are probably the representatives of the primary basal plates of the embryo. There is also a similar large oval plate, slightly convex, on the inner side of the papularium, which appears to be the representative of the primary radial plate. No definite order is discernible in the arrangement of the paxillæ, and no pedicellariæ are present on the abactinal area.

The supero-marginal plates, eighteen in number from the median interradial line to the extremity, form a moderately broad, definite, and well-rounded border on the abactinal surface; they are longer than broad, and the suture or line of junction between adjacent plates is more than usually oblique, passing from within outwards adorally. The height and breadth are subequal, the latter dimension being perhaps slightly the greater, except in the innermost part of the series. Each supero-marginal plate bears a single, short, conical spinelet, broad at the base and tapering throughout to a sharply pointed extremity. They are placed upon, or even on the lateral side of, the rounding of the plate. The fourth or fifth from the base of the ray measures about 2·25 mm. in length; and they decrease in size as they proceed outwards, whilst the innermost pair are very small. The rest of the surface of the supero-marginal plate is covered with minute, uniform, and tolerably closely placed thornlets.

The infero-marginal plates are rather higher than the superior series, except on the inner part of the ray; and they show a decided tendency to alternate with the companion series instead of each being placed immediately opposite or under the corresponding plate; the upper margin of the infero-marginal plates and the lower margin of the supero-marginal plates being angulated so as to appear superficially bifacetted. The breadth of the infero-marginal plates is greater than that of the superior series; and their breadth on the inner part of the ray is greater than the length, but the latter dimension increases and becomes the greater on the outer part of the ray. Each plate bears a short lateral spine near the upper margin, of the same size and character as those on the supero-marginal plates; and the rest of the plate is covered with small, uniform, tolerably closely placed thornlets, like those on the superior series of plates, amongst which no larger spinelets whatever occur.

The adambulacral plates are elongate and narrow, excepting the prominent angular extension into the furrow. Their armature consists of:—(1.) A furrow series of seven short, cylindrical, obtusely pointed spinelets (the median three or more, the longest), arranged on the free margin of the plate which projects into the furrow, and forming a scoop-like

group, which in posture fancifully resembles the hand when held slightly hollowed as if to catch a ball. (2.) A single, conical, tapering, sharply pointed spine, nearly as long as the short lateral spines, stands on the actinal surface of the plate. There are also on the surface of the plate two or three very small spinelets or thornlets on both sides of this central spine placed at each end of the plate, in such a way as to appear to form a continuation of the marginal series above described; and there may be one or two small spinelets, equal in size to these lateral ones, or a trifle larger, near the base of the central spine. Beyond these there are no other spinelets on the adambulacral plates. The scoop-like groups of the marginal series extend over the furrow, and touch the corresponding groups of the opposite side, widely separating the pairs of ambulacral tube-feet.

The mouth-plates are comparatively large and broad, and the united pair are conspicuous in consequence of their subtubercular character, and of a well-defined depression at the outer extremity of the pair, in which no plate is present between them and the marginal plates. The free margin of the united pair is well rounded and more tumid laterally than a semicircle; its armature consists of six spinelets for each plate, the inner one being twice as large as the others, which are nearly equal in length; there is thus a pair of prominent but short spinelets at each mouth-angle directed horizontally over the buccal membrane, whilst the remaining five mouth-spines of each plate maintain in their posture more or less of the scoop-like character of the adambulacral armature. On the actinal surface of the plates there is one secondary mouth-spine similar in character to, but scarcely as large as, the actinal spines on the adambulacral plates; a lineal series of about six small, uniform, thorn-like spinelets runs parallel to the median suture; and three or four similar spinelets also form a lineal series behind the secondary mouth-spine.

No actinal intermediate (ventral) plates of any kind are present; and the marginal plates are contingent on the adambulacral plates throughout. The ambulacral tube-feet have a small, but definite and rounded, knob-like tip.

One large, compound pedicellarian apparatus is situated in each interradium, placed between the two innermost infero-marginal plates. It is of oval form, with the length about equal to half the breadth of the marginal plates, and its margin is beset with ten to twelve small pointed spinelets directed horizontally from the two sides in order to close over a central cavity. This organ is placed close to the inner margin of the marginal plates, and encroaches equally upon each of the two plates. A similar pedicellarian apparatus occurs in the lateral vertical wall of three of the interbrachial arcs, situated between the two innermost supero-marginal plates. No other pedicellariæ are present.

The anal aperture is subcentral and very distinct; and the spinelets of the surrounding paxillæ, which form its margin and close over the aperture, are sensibly more robust than any of the others.

The papulæ are confined to a small group, which forms a definite papularium at the base of each ray, and there are not more than six papulæ in each, and sometimes only

five. Their arrangement is not very regular, but appears normally to fall into two longitudinal series of three each; the central pair being wider apart than the others.

The madreporiform body, which is situated midway between the centre of the disk and the margin, is small and circular, but is convex and conspicuous, and with its surface grooved with rather coarse striation furrows, which have rather a reticulate appearance.

Colour in alcohol, ashy white, with a yellowish or ochre shade along the ray.

Locality.—Station 205. West of the Island of Luzon (Philippines). November 13, 1874. Lat. 16° 42′ 0″ N., long. 119° 22′ 0″ E. Depth 1050 fathoms. Blue mud. Bottom temperature 37°·0 Fahr.; surface temperature 82°·0 Fahr.

Remarks.—This is an elegant and well marked little form; and *Pontaster trullipes* is readily distinguished from the other species known, by the small and simple paxillæ, without a central spine; by the absence of actinal intermediate plates; and by the presence of the large isolated pedicellariæ only in the interradial lines. In addition to these features the posture of the adambulacral armature is in a marked degree characteristic.

12. *Pontaster subtuberculatus*, n. sp. (Pl. V. figs. 3 and 4; Pl. XIII. figs. 7 and 8).

Rays five. R = 24–25 mm.; r = 7·5 mm. R = 3·25 r. Breadth of a ray near the base, 7 mm.

Rays rather short, broad at the base, and tapering continuously to the extremity, which is comparatively broad and obtuse. Interbrachial arcs well rounded. Abactinal surface flat, sloping slightly to the extremities of the rays. The paxillar area slightly depressed below the level of the marginal plates. Actinal surface flat and level.

The paxillæ of the abactinal area are small and low, but very distinctly spaced; their crown consists of a group of eight to sixteen small, short, uniform, papilliform granules or spinelets, of which from three to five are central and surrounded by the others, but none are longer or more prominent than the rest. On the outer half of the rays the paxillæ have not more than three to five spinelets in each. In each interradial line, midway between the centre and the margin, there is a paxilla about twice the size of any of the others; and these are probably the representatives of the primary basal plates of the embryo. No definite order is observable in the general arrangement of the paxillæ, and no pedicellariæ are present.

The supero-marginal plates form a broad and slightly raised border on the abactinal surface, the intermediate paxillar area midway on the ray being very little broader than the marginal plates, and the breadth of the latter diminishes towards the extremity, whilst the diminution in the breadth of the paxillar area along the greater portion of the ray is comparatively slight. The supero-marginal plates are seventeen in number from the median interradial line to the extremity; their breadth is greater than their length, and

the length slightly greater than the height. They are tumid along their breadth, with a distinct but shallow channel between each, the course of which is slightly oblique from within outwards. Each supero-marginal plate bears a single robust, dumpy, obtusely rounded, and very short spinelet, little more than an elongate tubercle, which is situated just over the rounded angle of the plate, and quite on the lateral side. These tubercles are present on every plate up to the extremity, excepting only the innermost plate on one side of the median interradial line in each interbrachial arc, viz., the left-hand plate (regarded from the centre) in the odd posterior and the left postero-lateral interradia, and the right-hand plate in the other interradia. The general surface of the supero-marginal plates is covered with very minute and widely-spaced conical granules.

The infero-marginal plates are similar in size and character to the superior series; each bears a short, robust, and rather bluntly pointed lateral spine, the longest not more than 1·5 mm. Behind this, in the median line of the plate, are two or three much smaller and sharply pointed spinelets, that nearest to the lateral spine being the only one worthy of the name—the others, when present, for they are not traceable on the outer part of the ray, being merely thornlets slightly larger than the small widely spaced thornlets which cover the general surface of the infero-marginal plates.

The adambulacral plates are large and broad, with a semicircular margin projecting into the furrow. Their armature consists of :—(1.) A furrow series of six short, slightly tapering, delicate spinelets, the outermost on each side the shortest, arranged on the furrow margin, radiating slightly apart, and forming a fan when directed over the furrow. (2.) A short, robust, conical spinelet, not much longer than the largest furrow spinelet, but much more robust, placed on the actinal surface of the plate, usually with a small thorn-like spinelet on each side near the margin; and there are no other spinelets on the plate.

The mouth-plates are rather small, convex actinally, and with an open median suture. The free margin of the united pair has an almost semicircular contour, and its armature consists of seven or eight small, short, slightly tapering spinelets on each plate, which increase slightly in length as they proceed inward, the innermost pair being conspicuously the most robust, but only a little longer than the adjacent spines. There are three or four small spinelets on the actinal surface of the plates arranged parallel to the median suture, and two or three on the outer portion. Very few of the actinal spinelets now remain on the plates, but their former existence is indicated by the small tubercles on which they were articulated; all appear to have been very small, and I am unable to distinguish any as large as the outer or actinal spine on the adambulacral plates.

The actinal intermediate plates occupy a very limited area, and do not extend beyond the fifth adambulacral plate in the largest specimen, about sixteen being present in the whole area. In a smaller example the number is much less, and their extent still more limited.

Each plate bears a few small pointed thorn-like spinelets, rather widely spaced, but at the same time more or less grouped.

The anal aperture is subcentral and very distinct, and is emphasised by a few of the spinelets of the paxillæ that surround it being sensibly more robust than the rest.

The papulæ occupy a limited area at the base of the ray. They appear smaller and perhaps more numerous than in some species, but I am unable to give their number accurately; and no definite order of arrangement is discernible.

The madreporiform body, which is small, circular, and slightly convex, is situated midway between the centre and the margin of the disk; the striation furrows with which its surface is grooved are rather coarse, and radiate centrifugally with more than usual regularity.

Colour in alcohol, a greyish or ashy white.

Young Phase.—A small example, which measures $R = 16$ mm., $r = 5$ mm., and has thirteen or fourteen supero-marginal plates, accords in all respects with the larger specimen, and is perfectly recognisable. The anal aperture is distinct; there are a few comparatively large papular pores at the base of the rays; and the large isolated paxillæ are entirely characteristic. The adambulacral plates have not more than four or five spines on the furrow margin, though there is a small thornlet at each extremity of the series at the margin of the actinal surface. On the infero-marginal plates the small secondary spinelets below the lateral spine are not yet distinguishable from the miliary spinulation of the plate. The madreporiform body is very simple and placed close to the marginal plates.

Locality.—Station 164. Off the coast of Australia, east of Sydney. June 12, 1874. Lat. 34° 8′ 0″ S., long. 152° 0′ 0″ E. Depth 950 fathoms. Green mud. Bottom temperature 36°·5 Fahr.; surface temperature 69°·5 Fahr.

Remarks.—This species is readily distinguishable by the broad margin of the supero-marginal plates on the abactinal area, by the tubercles borne on these plates, by the absence of pedicellariæ, and by the character of the large isolated paxillæ on the abactinal area; and further by the short and comparatively obtuse rays. *Pontaster subtuberculatus* may probably be regarded as the southern representative of *Pontaster venustus*.

Subfamily Plutonasterinæ, Sladen, 1886.

Genus *Dytaster*, Sladen.

Dytaster, Sladen in Narr. Chall. Exp., 1885, vol. i. p. 608.

Disk more or less inflated. Rays very long and attenuate, often subcarinate along the median line abactinally, very slightly flexible.

Marginal plates rectangular; the supero-marginal plates thin and lamelliform, confined more or less to the lateral wall of the ray, which is usually vertical. The plates of the superior series are directly superposed on the corresponding plate of the inferior series,

and the contingent horizontal margins of both plates are consequently straight. The plates of both series usually armed with one more or less prominent thorn-like spine, but this may be aborted or may be absent, especially in young forms. The general surface of the plates of both series covered with short papilliform spinelets or granules.

Abactinal area with small rounded scale-like plates, bearing small pseudo-paxillæ, more or less well-developed, and usually forming a closely packed covering. No definite order of arrangement. Papulæ numerous and generally distributed.

Actinal interradial areas well-developed, with numerous intermediate (ventral) plates, arranged in more or less definite columns, but often difficult to distinguish.

Armature of adambulacral plates consisting of:—(1.) A longitudinal furrow series of short spines, usually compressed laterally, subprismatic and lamelliform, standing parallel to one another. (2.) One or more longitudinal series of papilliform spinelets or granules on the actinal surface; in some forms the first series are well-developed spinelets, and nearly as large as those of the furrow series; and in some there is a single enlarged spinelet amongst the first series.

Madreporiform body very large, compound, placed near the marginal plates, covered with paxillæ.

Pedicellariæ (subvalvuliform) may be present on the abactinal and actinal interradial areas.

Anal aperture subcentral.

Actinostome widely expanded, with large fleshy lip.

Synopsis of the Species included in the Genus Dytaster *herein described.*

A. With a single long secondary spine on the actinal surface of the adambulacral plates. Lateral margins of the rays angularly rounded . . . . . *spinosus.*

B. No long secondary spine on the actinal surface of the adambulacral plates or only represented at the extreme tip. Lateral margins of the rays vertical.

a. With more than one row of secondary spinelets or granules on the actinal surface of the adambulacral plates . . . . . .

a. With a well-developed series of secondary spines. Ten to twelve spinelets in the furrow series . . . . . *exilis.*

b. Secondary series of spines little more than papilliform granules. Only five or six true spinelets in the furrow series.

α. Supero-marginal and infero-marginal plates with prominent spines.

i. Disk small, rays long. With pedicellariæ on the actinal surface . . . . . *madreporifer.*

ii. Disk large, rays comparatively short. No pedicellariæ on the actinal surface . . . . . *nobilis.*

β. Supero-marginal plates with a tubercle, infero-marginal plates with an aborted spine . . . . . *æquivocus.*

b. With only one row of secondary granules on the adambulacral plates. .

a. Marginal plates armed. Actinal interradial areas well developed . *biserialis.*

b. Marginal plates unarmed. Actinal interradial areas very small . . *inermis.*

Chorology of the Genus Dytaster.

α. Geographical distribution:—

Atlantic: Four species between the parallels of 40° N. and 40° S.

Dytaster madreporifer and *Dytaster exilis*, var. *carinata*, off the coast of North America. *Dytaster biserialis*, between Madeira and the Azores. *Dytaster exilis*, var. *gracilis*, west of Tristan da Cunha. *Dytaster nobilis*, off the coast of South America, east of Buenos Ayres.

Pacific: Two species between the parallels of 40° N. and 40° S.

Dytaster spinosus, in the Mid-North Pacific, near the meridian of 180°. *Dytaster exilis*, off the coast of South America, between Valparaiso and the Island of Juan Fernandez. Varieties of this species are found in the North and South Atlantic, as noted above.

Eastern Archipelago: Two species between the parallels of 10° N. and 10° S.

Dytaster inermis, off the northern extremity of Celebes. *Dytaster æquivocus* in the Arafura Sea, west of the Arrou Islands.

β. Bathymetrical range: 800 fathoms to 2650 fathoms.

All the species are confined to the Abyssal zone—one only (*Dytaster æquivocus*) being found at a less depth than 1000 fathoms.

Greatest range of one species: *Dytaster madreporifer*, 1240 to 1700 fathoms. *Dytaster exilis*, with its varieties, ranges from 1375 to 1900 fathoms.

γ. Nature of the Sea-bottom: Four species—*Dytaster inermis*, *Dytaster madreporifer*, *Dytaster nobilis*, *Dytaster exilis*, var. *carinata*, are found on Blue mud. The type-form of *Dytaster exilis* and its variety *gracilis* are found on Globigerina ooze. Three species—*Dytaster biserialis*, *Dytaster spinosus*, *Dytaster exilis*, and *Dytaster exilis*, var. *gracilis*, are found on Globigerina ooze. *Dytaster æquivocus* is found on Green mud only, in 800 fathoms.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Dytaster æquivocus . . .	Eastern Archipelago.	800	Green mud.
Dytaster biserialis . . .	N. Atlantic.	2025	Globigerina ooze.
Dytaster exilis . . .	S. Pacific.	1375	Globigerina ooze.
Dytaster exilis var. *carinata* .	N. Atlantic.	1700	Blue mud.
Dytaster exilis var. *gracilis* .	S. Atlantic.	1900	Globigerina ooze.
Dytaster inermis . . .	Eastern Archipelago.	2150	Blue mud.
Dytaster madreporifer . .	N. Atlantic.	1240 to 1700	Blue mud.
Dytaster nobilis . . .	S. Atlantic.	2650	Blue mud.
Dytaster spinosus . . .	N. Pacific.	2050	Globigerina ooze.

1. *Dytaster spinosus*, n. sp. (Pl. V. figs. 1 and 2; Pl. IV. figs. 11 and 12).

Rays five. R = 160–164 mm.; r = 30 mm. R > 5r. Breadth of a ray near the base (between the second and third supero-marginal plates), 22 mm.

Rays tolerably elongate, robust, and tapering, more or less depressed, with the lateral walls angularly rounded. Interbrachial arcs wide and openly rounded. Disk comparatively large and massive. Abactinal area of disk slightly inflated, especially opposite the base of the rays, the inflation being continued for a short distance along the abactinal surface of the ray, which is at first regularly convex, but becomes flat before half the length is attained, and continues so up to the extremity. Actinal surface of the disk prominent at the mouth-angles and sloping thence to the margin; that of the rays slightly convex, giving them more or less of a rounded appearance when viewed from below.

The abactinal surface of the disk and rays is covered with small closely crowded paxillæ, composed of short, cylindrical, papilliform, obtusely tipped, equal-sized spinelets, seven to ten in each. Paxillæ with fewer spinelets are interspersed amongst the large ones; and on the outer half of the ray seldom more than three to five spinelets occur, and these are reduced to mere papilliform granules. The spinelets in the paxillæ upon the disk and inner half of the rays stand nearly perpendicular, in little brush-like groups, but are so closely crowded in this region that it is often impossible to distinguish the individual paxillæ. No pedicellariæ are present.

The supero-marginal plates, forty-two to forty-four in number from the median interradial line to the extremity, are wholly visible when the starfish is viewed from above. They form a broad, sloping, or bevelled border to the abactinal surface, and even a portion of the infero-marginal plates is also visible; the latter forming exclusively the outline of the ray. The supero-marginal plates are rectangular, with the length greater than the height, excepting a few plates in the interbrachial arc, in which the dimensions are subequal. On the outer part of the ray the height is more than half the length. Each plate bears on its upper margin a short and comparatively delicate, straight, cylindrical, tapering, sharply pointed spine, the longest about 3·5 mm. in length, and they decrease very slightly as they proceed along the ray. The spines are directed upwards and at an angle of about 45° towards the extremity. Rarely some plates bear two spines, one generally smaller than the other. The surface of the plate is covered with small, uniform, papilliform granules, rather widely spaced on the middle of the plate, but becoming crowded and more elongate at the adoral and aboral margins.

The infero-marginal plates correspond to the superior series, their line of union being perfectly horizontal. These plates have their surface curved, so that a portion is visible when the starfish is viewed from above, and they form entirely the outer margin of the ray. Indeed, beyond the middle of the ray their extent upon the abactinal area is nearly as great as on the actinal, and the rounding is slightly angular. Each plate bears on the

rounded angle a single, short, cylindrical, tapering, sharply pointed spine, about the same size as the supero-marginal spine, directed at an angle outward and towards the extremity. The surface of the plate is covered with short papilliform granules, similar to those on the supero-marginal plates, which, however, become slightly larger and more widely spaced on the median part of the actinal area. They are crowded at the adoral and aboral margins, and a few at the base of the lateral spine are definitely spiniform. All are invested with delicate membrane.

The adambulacral plates are long and narrow, and their length is such that they frequently appear to be correspondent to the infero-marginal plates; but careful examination soon shows that this is merely deceptive. The furrow margin is straight. The armature consists of:—(1.) A furrow series of ten small, moderately elongate spinelets, slightly curved, with convexity towards the furrow, compressed laterally, and of nearly uniform breadth throughout, the tip being rounded, and their character is in consequence decidedly lamelliform. The outer spine at each extremity of the series is rather smaller than the others, which are subequal, and measure about 2·25 mm. in length, or slightly more on the innermost plates of the ray. The spines stand parallel and touch one another, forming a straight compact comb, and are invested with membrane. (2.) On the actinal surface of the plate, and immediately behind the furrow series, is a parallel series of five or six short, cylindrical, papilliform spinelets, shorter than the furrow series and rather wide apart; and external to this series, or sometimes forming one of it, is a cylindrical and very slightly tapering spinelet about 4 mm. in length, sometimes even a trifle more—consequently a very conspicuous feature in the armature. Its position is generally rather nearer the aboral end than midway on the plate. There are seven or eight very small, equal, papilliform spinelets along the outer margin of the plate, and sometimes an incomplete series between this outer series and the series next the furrow spines. All the small spinelets, however, upon the actinal surface of the plate, are more or less irregular in their disposition, and this is especially noticeable in the inner part of the ray. No pedicellariæ are present; the surface of the plate is covered with membrane, and each of the papillæ is also thinly invested.

The mouth-plates are large, and the united pair are convex actinally and extend prominently towards the actinostome. Their armature consists of a marginal series of fifteen or sixteen short spinelets on each plate, similar in character to the furrow series on the adambulacral plates, but which become more cylindrical and papilliform on the outer part of the series. One or two of the innermost mouth-spines are a little longer than the rest, and these decrease slightly as they recede from the mouth. The actinal surface of the plate is covered with numerous, short, papilliform spinelets, amongst which no order of arrangement is discernible; they are subequal in length, excepting about four at the extreme inner end of the mouth-angle, immediately behind the marginal series, to which they are nearly equal in length; and a second series of four or five behind these,

intermediate in length and robustness between them and the general echinulation of the area above mentioned.

The actinal interradial areas are large and well developed, and extend as far as the ninth or tenth adambulacral plate. They comprise numerous intermediate plates arranged in more or less regular series between the adambulacral plates and the marginal plates; the separate plates are to a certain extent indicated by pseudo-sutures and the arrangement of the numerous short, equal, papilliform spinelets which they bear. The form of the groups is often rectangular, the papillæ are extremely short, and there is no tendency whatever to simulate paxillæ, the papillæ appearing to spring from the membrane which uniformly covers the whole area.

The anal aperture is subcentral and distinct, though there is no modification of the paxillæ surrounding it.

The madreporiform body is compound and of great size. It occupies a circular area 13·5 mm. in diameter, the outer margin of which is two to three mm. distant from the marginal plates. The area is rather higher than the plane of the abactinal surface, and is rendered conspicuous by the greater size of the paxillæ which cover it, the spinelets composing them being a little longer and more robust. The striated surface is entirely hidden from superficial view. When the spinelets are removed the furrows are seen to be remarkably fine and to appear to mount the base or pedicle of the paxilla.

The ambulacral tube-feet have a small mamelon-like conical termination.

Colour in alcohol, a greyish or yellowish white, with a slightly brownish or warmer shade on the abactinal paxillar area.

Locality.—Station 246. In the Mid-North Pacific, between Yeddo and San Francisco, near the meridian of 180°. July 2, 1875. Lat. 36° 10′ 0″ N., long. 178° 0′ 0″ E. Depth 2050 fathoms. Globigerina ooze. Bottom temperature 35°·1 Fahr.; surface temperature 73°·0 Fahr.

Remarks.—This species is at once distinguished from all the others in the genus by its broad and comparatively low rays, with the angularly rounded margin and the strong inward bevel of the whole surface of the supero-marginal plates towards the abactinal surface. It is further most conspicuously marked by the presence of the single long secondary spine on the actinal surface of the adambulacral plates behind the furrow series throughout the ray,

2. *Dytaster exilis*, n. sp. (Pl. II. figs. 3 and 4; Pl. IV. figs. 9 and 10 : the var. *gracilis*).

Rays five. $R = 124$ mm.; $r = 19$ mm. $R > 6{\cdot}5\,r$. Breadth of a ray near the base, 14 mm.

Rays elongate, very narrow and attenuate, tapering slowly from the base to the extremity. Lateral walls rather high and vertical. Interbrachial arcs wide, open, and well-rounded. Disk small. Abactinal area of the disk more or less inflated, especially at the

base of the rays, convex and arched along the rays. Actinal surface of the disk prominent and tubercular at the mouth-angles, but flat and level externally and along the rays, forming, with the lateral wall, a sharp angular margin.

The abactinal surface of the disk and rays is covered with small closely crowded paxillæ, which are composed of short, cylindrical, papilliform, obtusely tipped, equal-sized spinelets, seven to ten, or occasionally more in each on the disk, but fewer at the extremity of the rays. These spinelets stand vertically, in little round brush-like groups, distinctly paxilliform upon the disk, but becoming very low and granule-like towards the end of the ray. No pedicellariæ are distinguishable on the abactinal surface.

The supero-marginal plates, forty-two in number from the median interradial line to the extremity, are confined entirely to the lateral wall, except perhaps a very faint bevel at the extremity of the ray; and it is only here that they have a tendency to form a visible border to the abactinal surface when viewed from above. When seen from the side the plates are rectangular, with the length slightly greater than the height, excepting on the nine or ten innermost plates on each side of the median interradial line, in which the height is at first slightly greater than, and then equal to, the length. On the outer part of the ray the length is about twice the height. Each plate bears on its upper margin a short, conical, sharply pointed spine, the longest about 2·5 mm. in length, and they decrease very slightly as they proceed along the ray. The surface of the plate is covered with short papilliform granules, tolerably closely placed, but especially crowded near the vertical margins, where they are also smaller.

The infero-marginal plates correspond to the superior series, and their dimensions in the lateral wall are approximately similar. Their breadth on the actinal surface is greater than their length on the inner part of the ray, about equal midway between the extremities, and less than the length on the outer part. The junction of the actinal and lateral areas is more or less angular along the greater portion of the ray, but more rounded on the plates in the interbrachial arc; the sutures between these plates are also bevelled, which gives a certain convexity and appearance of distinctness to the infero-marginal plates in this region, which is not noticeable elsewhere. The same character is also present in the corresponding supero-marginal plates. Each infero-marginal plate bears a single, short, conical spine, similar in size and character to the supero-marginal spine. It is placed on the angle at the junction of the lateral and actinal planes, and is directed horizontally and at a slight angle towards the outer extremity. The surface of the plate is covered with short papilliform granules similar to those on the supero-marginal plates; they are crowded and smaller near the adoral and aboral margins, and are slightly longer on the actinal area; occasionally also a few at the base of the lateral spine are more definitely spiniform. All are invested with a delicate membrane.

The adambulacral plates are long and very narrow, subequal in length to the infero-marginal plates, to which they have the appearance of corresponding more or less closely.

Their margin towards the furrow is straight, or very faintly convex. The armature consists of :—(1.) A furrow series of twelve short, cylindrical, papilliform spinelets, the median ones slightly longer than the others, slightly compressed laterally, but not square in section, standing parallel to one another, and forming a long but low, straight comb. The longest do not exceed 2 mm. in length. (2.) On the actinal surface of the plate, and close behind the marginal series, is a straight row of seven or eight short, subequal, papilliform spinelets, which are more widely spaced than the furrow series, and are also more robust, but not more than half their length. This series is closely pressed against the furrow series, and the spinelets in both are enveloped in membrane, those in the outer series being especially papilliform in their appearance. Along the outer margin of the plate is another lineal series of seven or eight small, equal, papilliform granules ; and these in consequence of the narrowness of the plate are very near to the series above described, but separated by a well-defined though very narrow naked space. No other spines, granules, or pedicellariæ are present.

On the outer third of the ray there is a slightly enlarged spinelet on the actinal surface of the plate, usually situate in the first actinal series, which is longer than any of the other spinelets on the plate and more robust, and sometimes equal in size to the spines on the marginal plates. There is no trace whatever of its presence on the plates on the inner half of the ray.

The mouth-plates are large and conspicuous, the united pair being elongately oval, and prominently convex actinally. They protrude far over the actinostome, and as seen with their armature reflected perpendicularly, have a peculiar sagittiform outline. The armature consists of a marginal series of about fourteen short, compressed, papilliform spinelets on each plate, all standing parallel, and capable of being directed perpendicularly to the plane of the actinal surface ; the inner spines forming a wedge-shaped group, and the outer seven appearing, to a certain extent, like an independent semicircular series. On the actinal surface of the plate are numerous, irregularly disposed, small, papilliform spinelets, appearing more or less clavate in consequence of their membranous investment, and nearly subequal in length, except two or three larger ones at the extreme inner end of the mouth-angle, placed close to the marginal series of true mouth-spines, and contributing with them to the formation of the wedge-shaped group above mentioned.

The actinal interradial areas, though small, are well developed, extend as far as the fifth adambulacral plate, and contain numerous intermediate plates disposed in regular series between the adambulacral and marginal plates. The plates bear groups of small papilliform spinelets, which are remarkable from the fact that each bears centrally a conspicuous pedicellarian apparatus, usually formed of four thickened and enlarged spinelets, the other spinelets of the plate or paxillæ being very much smaller, and forming a marginal surrounding series.

The anal aperture is subcentral, but indistinct.

The madreporiform body is compound and of large size, though smaller than in *Dytaster madreporifer*, and not so conspicuous; for instead of being elevated as in that species, it is either flush with the general abactinal surface, or in a slight concavity. The area is subcircular in outline, and comes very near to the marginal plates; its diameter is nearly 6 mm. The plates bear paxillæ of larger size, and with slightly more robust spinelets, but otherwise of identical character, which entirely hide the striations from superficial view; and these paxillæ, like the others upon the abactinal area, are devoid of pedicellariæ.

Colour in alcohol, a bleached ashy grey.

Locality.—Station 300. Off the coast of South America, between the island of Juan Fernandez and Valparaiso. December 17, 1875. Lat. 33° 42′ 0″ S., long. 78° 18′ 0″ W. Depth 1375 fathoms. Globigerina ooze. Bottom temperature 35°·5 Fahr.; surface temperature 62°·5 Fahr.

Remarks.—This species is distinguished from *Dytaster madreporifer* by the coarser and more distinct paxillæ of the abactinal surface, by the numerous large pedicellariæ on the actinal interradial areas, and by the well-developed series of secondary spines on the actinal surface of the adambulacral plates. The two forms have a very different facies.

2*a*. *Dytaster exilis*, var. *gracilis*, nov. (Pl. II. figs. 3 and 4; Pl. IV. figs. 9 and 10).

There is a single example from Station 133 which I propose to rank provisionally as a variety of this form, although it may afterwards be found to merit recognition as a distinct species. With such limited material the course I have adopted seems preferable if only for the purpose of indicating its near affinity to the *Dytaster exilis* type. The following are the points of difference.

The measurements are $R = 85$ mm.; $r = 16$ mm.; $R < 5{\cdot}5\,r$. Although this example is smaller than the type there are a greater number of supero-marginal plates, the variety having forty-eight whilst the type has forty-two. Its smallness, therefore, is not a sign of immaturity. The rays are proportionally narrower and more delicate. The paxillæ of the abactinal surface are smaller and form an extremely compact and crowded area. In the actinal interradial areas the arrangement of the intermediate or ventral plates is very distinct and regular, and the plates bear a paxilliform group of small spinelets, much longer and more delicate than in the type; the spinelets in each group radiate apart, and no pedicellariæ are formed, or at any rate none of the spines are specially modified. The character of these paxilliform groups gives a very different appearance to the area as compared with that of the type.

In the armature of the adambulacral plates there are seven or eight spinelets in the second series, and these are shorter and more delicate than in the type. Furthermore the solitary elongate spine which occurs in this series, extends fully to the middle of the ray, whilst in the type-form they are to be found only at the extremity. The characters that

at once distinguish the form, and may ultimately entitle it to be ranked as a distinct species, are the greater number of supero-marginal plates, the narrowness of the rays, the character of the spinulation of the actinal interradial areas, the absence of pedicellariæ alike on this area and on the abactinal area, and finally the character of the adambulacral armature. The madreporiform body appears to be somewhat smaller.

Locality.—Station 133. In the South Atlantic, west of the island of Tristan da Cunha. October 11, 1873. Lat. 35° 41′ 0″ S., long. 20° 55′ 0″ W. Depth 1900 fathoms. Globigerina ooze. Bottom temperature 35°·4 Fahr.; surface temperature 58°·0 Fahr.

2*b*. *Dytaster exilis*, var. *carinata*, nov.

This variety is characterised by the high and strongly keeled rays—a feature further emphasised by their narrowness. The paxillæ upon the disk are comparatively large and distinct, and composed of rather robust but low papilliform spinelets, whilst along the ray the paxillæ become extremely small, and seldom have more than three to five papillæ in each. There are very numerous valvate pedicellariæ along the margin of the abactinal area of the ray, and also some upon the disk. In the type-form there are no pedicellariæ on the abactinal area. The actinal interradial areas have numerous very large well-developed pedicellariæ irregularly arranged; the individual intermediate plates which cover the area are quite indistinguishable, and they bear small skin-covered papilliform granules. In the armature of the adambulacral plates the spines of the furrow series are large and thick, compressed transversely; those of the second series are rather wide apart, not more than five or six being present; they are dagger-shaped, compressed longitudinally, and are nearly as long as the furrow series. External to them is a row, sometimes two, of small papilliform spinelets or granules. The solitary enlarged spinelet in the second series of spines on the adambulacral plates is confined quite to the tip of the ray, where it is thick and stumpy. The madreporiform body is remarkably large, and with very coarse paxillæ upon it. There are forty-two or forty-three supero-marginal plates. The measurements are R = 98 mm.; $r = 16{\cdot}5$ mm.

Young Phase.—A small example taken at the same station seems to me to belong with little doubt to this form. The dimensions are R = 11·5 mm.; $r = 3{\cdot}75$ mm. Its general appearance at first glance is very different from that of the adult, its facies and proportions resembling those of *Astropecten*. There is as yet no indication of the narrow carinate rays of the adult. There are eleven supero-marginal plates between the median interradial line and the terminal plate. These extend well upon the abactinal surface, their breadth being equal to, or even slightly greater than, their length, and they form a well-defined border to the abactinal surface as seen from above, the breadth a little beyond the middle of the ray being nearly as great as that of the intermediate paxillar area. The margins of the ray are well rounded. The surface of the plates is covered with small, rather widely

spaced, papilliform granules, and the prominent "dorsal" spines on the supero-marginal plates are not yet developed. The infero-marginal plates are covered with spiniform granules or thornlets longer and more pointed than those on the supero-marginal plates. There is a distinct though extremely minute lateral spine, and one or two of the thornlets near its base are slightly larger than the rest, especially on the outer part of the ray.

The adambulacral plates, which are long and narrow, have their generic character clearly presented. There is a straight furrow series of five or six short, cylindrical, obtusely tipped spinelets, and behind these a secondary series of four or five similar and equal-sized spinelets. This uniformity in size and character is a very interesting and noteworthy feature in the young form. No other spinelets or granules are present on these plates. Several well-formed large pedicellariæ occur in each of the actinal interradial areas, but I have found none elsewhere upon this young example. The paxillæ of the abactinal area have already more or less of the papillose character of the adult.

Locality.—Station 44. Off the coast of North America, east of Maryland. May 2, 1873. Lat. 37° 25′ 0″ N., long. 71° 40′ 0″ W. Depth 1700 fathoms. Blue mud. Bottom temperature 36°·2 Fahr.; surface temperature 56°·5 Fahr.

Remarks.—This variety resembles the type more nearly than the variety *gracilis* does. The wide separation of the geographical positions of the type and its two varieties is of the greatest interest, and bears evidence to the enormous range of the *Dytaster exilis* form, and of the comparatively small amount of variation exhibited by this type in what may well be spoken of as extreme limits of position. The type comes from the Pacific, off the western coast of South America, the nearly allied variety *carinata* from the North Atlantic, off the eastern coast of the United States of America, whilst the more divergent variety—if, indeed, it be not a distinct species—was dredged in the South Atlantic, westward of Tristan da Cunha.

3. *Dytaster madreporifer*, n. sp. (Pl. III. figs 3 and 4; Pl. XXXII. figs. 5 and 6).

Rays five. R = 113 mm.; r = 18 mm. R = 6·25 r. Breadth of a ray near the base (between the second and third supero-marginal plates), 14 mm.

Rays elongate, narrow, and tapering, of massive construction, subrigid, or only with very slight flexibility, perfectly rectangular in section, with rather high, vertical, square-cut lateral walls. Interbrachial arcs very wide and flatly rounded. Disk small. Abactinal surface of disk more or less inflated, subcarinate along the median line of the rays. Actinal surface of the disk prominent and tubercular at the mouth-angles, but flat and level externally and along the rays, forming with the lateral walls a sharp angle.

The abactinal surface of the disk and rays is covered with small closely crowded pseudo-paxillæ, which consist of four to seven small, uniform, papilliform spinelets, cylindrical, and obtusely tipped, borne on small, irregularly subcircular, squamiform bases. All are so short, uniform, and closely placed, that it is almost impossible to distinguish the individual

paxillæ in an entire specimen; and the appearance of the abactinal surface, either to the naked eye, or even under a low power of magnification, is that of a fine granulation. The pseudo-paxillæ upon the disk are larger than those along the rays, in that they are composed of more spinelets, but this is only noticeable under magnification, for the character is the same throughout both on disk and rays. A number of small pedicellariæ, formed of three or four slightly enlarged and modified spinelets, occur at intervals amongst the paxillæ, both upon the disk and along the sides of the abactinal surface of the rays.

The supero-marginal plates, forty-six or forty-seven in number from the median interradial line to the extremity, are confined almost entirely to the lateral wall of the ray, and although there is a slight sharp bevel towards the abactinal surface, little more than their thickness is visible when viewed from above. They constitute a very narrow but remarkably well-defined border to the rays and disk. When seen from the sides the plates are perfectly rectangular, the length being slightly greater than the height, excepting the seven or eight innermost plates on each side of the median interradial line in which the height is at first slightly greater than, and then equal to, the length. Each plate bears on its upper margin, immediately on the angle uniting the abactinal and lateral planes, a short robust, conical, sharply pointed spine, not placed exactly midway between the adoral and aboral extremities of the plate, but rather nearer the latter. It is directed parallel to the vertical plane through the axis of the ray, and points towards the extremity at an angle of about 45° to the horizontal. The longest of these spines measures about 2·5 mm., and they decrease in length slightly as they proceed along the ray. The surface of the plate is covered with small, hemispherical, widely spaced granules, which become crowded along the vertical margins, and two or three embracing the base of the conical spine are often more or less spiniform.

The infero-marginal plates are exactly correspondent to the superior series; their length and height in the lateral wall being the same as in the superior series on the inner portion of the ray, whilst the height diminishes proportionally rather more along the ray than in the superior series. Their breadth on the actinal surface is at first much greater, and afterwards only slightly less, than the length. The lateral and actinal planes form a right angle, the union being sharp and scarcely rounded. Each plate bears a single, short, conical spinelet, similar in size and character to the supero-marginal spine. It is placed on the angle at the junction of the lateral and actinal planes, and is directed horizontally and at a slight angle towards the outer extremity. On isolated and rarely occurring plates two spines may be present, one rather smaller than the other. The surface of the plate is covered with small, widely spaced hemispherical granules, with a tendency to become papilliform on the actinal surface. They are crowded along the adoral and aboral margins, and several at the base of the lateral spine are usually definitely spiniform.

The adambulacral plates are long and narrow, subequal to the infero-marginal plates, to which they appear to correspond throughout, with very few exceptions. The margin

towards the furrow is very slightly convex. Their armature consists of:—(1.) A furrow series of seven or eight moderately elongate, subprismatic spinelets, perfectly rectangular in section, slightly compressed laterally, and tapering slightly towards the tip, which is more or less pointed. The base is broad, with its greatest dimension transverse to the longitudinal axis of the ray; and when viewed in this aspect the tapering of the spine is seen to be considerable, but when viewed in the other dimension, parallel to the axis of the ray, the thickness of the spine is nearly uniform almost to the tip, and the tapering is very slight. The outermost spine at each extremity of the series is much smaller than the others, of which the median are the longest (about 2 mm. in length), and the rest decrease slightly as they recede on each side. In many cases there are not more than five worthy of being called marginal spinelets. The spines stand parallel and touch one another, the group thus forming a subtriangular or wedge-like comb, with the apex roundly truncate. (2.) On the actinal surface of the plate, behind the marginal series, is a more or less irregular row of about five or six small, cylindrical, rather widely spaced, subequal, papilliform granules, which in some specimens have a tendency to become more spiniform on a few of the plates on the inner part of the ray; and external to these is a second row of merely papilliform granules running along the outer margin of the plate. The inner eight or ten adambulacral plates, which are broader than the others, have several irregularly disposed papilliform granules or spinelets interspersed between the two series, and the regularity of the arrangement above noted is somewhat affected thereby. In the second lineal series, behind the furrow spines, at least along the inner half of the ray, is usually a small pseudo-pedicellaria, formed by two or three slightly modified papilliform spinelets, and its position is usually at the aboral extremity of the series, but not invariably so, neither is it always present.

The mouth-plates are large and conspicuous, the united pair being elongately oval, and prominently convex or subtubercular, rising abruptly from the otherwise level interradial area. Their armature consists of a marginal series of true mouth-spines about nine in number on each plate, similar in form and character to the furrow series on the adambulacral plates. The actinal surface of the plates is echinulate, with numerous irregularly disposed small papilliform spinelets, which increase slightly in length as they approach the inner end of the mouth-plates, where, however, they are less than the marginal or true mouth-spines, and can scarcely be said to become definite spinelets.

The actinal interradial areas are comparatively extensive and well-developed, reaching as far as the seventh or eighth adambulacral plate; they are covered with plates bearing paxilliform groups, which form series running between the adambulacral and the marginal plates, although a definite order is scarcely perceptible on account of the crowding of the small papilliform spinelets composing them; these short papillæ spring from a membrane which covers an apparently subcircular tabulum, and there are about nine or ten on each, some being central and some marginal, but with little regularity.

Incipient pedicellariæ, formed of two or usually three modified papillæ, are present on some of the plates.

The anal aperture is subcentral, but very indistinct.

The madreporiform body is of enormous size and of compound structure, being apparently made up of a number of plates. It occupies a subcircular area extending from the marginal plates to nearly midway between the margin and the centre of the disk, its diameter being about 11 mm. The surface of this area is covered with paxillæ, which are larger and more widely spaced than the paxillæ of the abactinal surface generally, and have their spinelets radiating nearly horizontally. The striation furrows are thus hidden from superficial view, but may readily be seen when the spinelets are removed. The striæ are of simple construction, and may easily be abraded. Amongst the paxillæ upon the madreporite are a considerable number of simple pedicellariæ, formed of three or four thickened spinelets. In addition to its great size the madreporiform body is rendered more conspicuous by being abruptly raised above the general level of the abactinal surface, which causes it to have a button-like or "put on" appearance.

The ambulacral tube-feet have a small flatly conical termination.

Colour in alcohol, a bleached yellowish white; with sometimes darker shades of dirty grey, or even patches of light brown upon the disk.

Localities.—Station 44. Off the coast of North America, east of Maryland. May 2, 1873. Lat. 37° 25′ 0″ N., long. 71° 40′ 0″ W. Depth 1700 fathoms. Blue mud. Bottom temperature 36°·2 Fahr.; surface temperature 56°·5 Fahr.

Station 45. Off the coast of North America, east of Delaware. May 3, 1873. Lat. 38° 34′ 0″ N., long. 72° 10′ 0″ W. Depth 1240 fathoms. Blue mud. Bottom temperature 37°·2 Fahr.; surface temperature 49°·5 Fahr.

Remarks.—This species is distinguished from all the others by its rigid rectangular rays, by the enormous and conspicuous madreporiform body, by the small and very compact paxillæ of the abactinal surface; and by the small and indefinite spinelets on the actinal surface of the adambulacral plates. The characters which separate it from *Dytaster nobilis* are discussed in the comparative description of that form.

4. *Dytaster nobilis*, n. sp. (Pl. III. figs. 1 and 2; Pl. XXXII. figs. 3 and 4).

This form is nearly allied to *Dytaster madreporifer*, with which I at first ranked it as a variety. On closer study I consider it to be a distinct species. It differs from *Dytaster madreporifer* in its larger size, greater development of disk, and shorter rays, the respective dimensions being R = 132 mm.; r = 29 mm.; R = 4·5 r. The rays are broader and more depressed, though with a more definite median carination. The paxillæ are larger, more distinct, and with fewer spinelets, which radiate from the small tabulum, the centre of which is often void, and often provided with a central granuliform spinelet. The crown of the paxilla has the appearance of being sheathed in a continuous membrane, con-

sequent on the expansion of the membrane at the base of the spinelets, where they are attached to the tabulum.

The supero-marginal plates are proportionally shorter than in *Dytaster madreporifer*; the length and height being subequal, and the former never in excess as in that species. They are also confined entirely to the lateral wall of the ray, and do not form a visible border when viewed from above.

The armature of the adambulacral plates is much simpler. The furrow series consists of six or seven spines, with one very small. They are greatly compressed laterally, slightly curved, and of nearly uniform breadth throughout. The secondary series immediately behind is altogether wanting, and there are no pedicellariæ. The row of papilliform granules along the outer margin is the only armature on the actinal surface of the plate.

The plates of the actinal interradial areas are large, and their spinulation can hardly be said to form true paxillæ, though the character is incipient. The small papilliform spinelets are rather widely spaced, and appear to spring from the uniform continuous membrane of the flat tabula.

The madreporiform body is of great size, occupying a circular area 12·5 mm. in diameter. It is not specially raised above the general abactinal surface as in *Dytaster madreporifer*. In one of the examples under notice its structure is well shown. It is built up of a number of plates all slightly convex, which give it an undulating character; some of the plates are more or less regularly hexagonal, and have their sutures distinct, but frequently the sutures are obliterated. The striation furrows cover the whole of all the plates, and are very fine and numerous; on some plates they are highly convoluted, on others simply wavy, and no definite order of direction is present. Paxillæ are distributed over the surface (more numerously in some specimens than in others), and they spring from the sutural junctions of the plates. Their pedicle is comparatively elongate and thin, and the spinelets of the crown radiate outwards, entirely hiding the striated surface of the madreporiform body from view when the paxillæ are numerous. The madreporic area is not quite close to the marginal plates, there being an intervening space of about 2 mm.

Colour in alcohol, a dirty brownish ashy grey.

Locality.—Station 325. Off the coast of South America, east of Buenos Ayres. March 2, 1876. Lat. 36° 44′ 0″ S., long. 46° 16′ 0″ W. Depth 2650 fathoms. Blue mud. Bottom temperature 32°·7 Fahr.; surface temperature 70°·8 Fahr.

Remarks.—One of the specimens is interesting from bearing a colony of small, naked, Hydroid-like polyps on its actinal interradial areas; the polyps are very small, isolated, erect and pedunculate, suggesting the appearance of an isolated, decalcified, small-crowned paxilla. The bases are united by delicate thread-like prolongations which pass to the neighbouring polyps and form a most delicate but wide-meshed reticulation amongst the ventral plates of the starfish. The polyps are wide apart and few in number, and are only to be detected with a magnifying glass.

5. *Dytaster æquivocus*, n. sp. (Pl. XXXVI. figs. 5 and 6 ; Pl. XXXIX. figs. 10–12).

Rays five. R = 18 mm. ; $r = 4{\cdot}75$ mm. $R < 4r$. Breadth of a ray between the first and second supero-marginal plates, 4·25 mm.

Rays moderately long and robust, tapering gradually from the extreme base to the extremity. Disk small. Interbrachial arcs rather angularly rounded. Abactinal surface subplane, subject to slight inflation, with a central conical peak. Actinal surface plane. Lateral walls rather high, rounded towards the abactinal and actinal surfaces.

The paxillæ of the abactinal surface are small and well-spaced, borne on comparatively large basement plates, with a large, low, robust, tuberculose central eminence upon which the crown is attached. The crown is composed of five to eight short, equal, papilliform granules (occasionally with a tendency to the spiniform character), which are disposed in a compact group, or radiate only very slightly apart. At the sides, near the base of the ray, the paxillæ show a tendency to be disposed in transverse series, more distinctly seen in some specimens than in others. The paxillæ are smaller on the flanks of the central cone and on the outer part of the rays.

The supero-marginal plates, sixteen in number from the median interradial line to the extremity, are large, and form a well-defined border to the disk and rays. When viewed from above their breadth is slightly greater than their length—this being an apparent rather than a real dimension, caused by the arching or curvature of the plate toward the abactinal surface. The median region of the plates is slightly tumid, but there is no definite channel between adjoining plates as in *Astropecten*. The supero-marginal plates bear a small, low, robust, papilliform tubercle near the upper margin, the largest being in the median region of the ray. This tubercle is greatly aborted or absent altogether on the innermost plate on each side of the median interradial line, and perhaps also at the extremity of the ray. The surface of the plate is covered with small uniform papilliform granules, rather widely spaced, except at the vertical margins of the plates.

The infero-marginal plates correspond exactly to the superior series, which are directly superposed. Their surface is covered with low papilliform granules, widely spaced on the median area on the actinal region of the plate. The plates bear on the rounded angle that unites the lateral and actinal areas of the test, or sometimes further upon the former, a small, pointed, and more or less adpressed, spinelet, directed upward and outward, and scarcely noticeable without a magniying glass. Up to the middle of the ray this spinelet may be accompanied by one or two much smaller microscopic spinelets, usually placed above it, and with a tendency to form a small compact vertical series or comb, adpressed to the ray, on the upper part of the plate near the aboral margin.

The adambulacral plates are elongate, but also rather broad on the inner half of the ray, and the margin towards the furrow is convex. Their armature consists of :—(1.) A furrow series of five or six small but rather long, cylindrical, obtusely tipped, delicate spinelets, which radiate slightly apart and form a fan over the furrow. (2.) The actinal

surface of the plate bears small, equal-sized, obtuse, papilliform granules, which, although not regularly arranged throughout, usually fall into two longitudinal series, more or less clearly distinguishable; and some additional granules are present on the inner plates of the ray near the mouth.

The mouth-plates are elongate, the united pair elliptical and prominently convex actinally, with the median suture widely open. Their armature consists of six to eight mouth-spines on each plate, all very small and subequal, excepting the innermost, which is large and robust, with an abruptly conical point. This spine forms with its companion a conspicuous pair of large spines, directed over the actinostome. A few small papilliform spinelets, irregular in position and number, but sometimes (and perhaps normally) forming a line parallel to the suture, stand on the actinal surface of the plates, those immediately behind the anterior spine being larger than the others.

The actinal interradial areas are small, very narrow, and occupied by comparatively few intermediate plates, which may extend as far as the third infero-marginal plate and the sixth free adambulacral plate. These plates bear small papilliform granules similar to those on the actinal surface of the adambulacral plates. The two innermost plates on each side of the median line immediately behind the mouth-plates bear five or six equal, longer and more robust spinelets, that form a compact and conspicuous group which simulates, if it does not actually perform the functions of, a pedicellarian apparatus.

The madreporiform body is very near the margin and partially concealed by paxillæ. The striations visible are coarse and few in number.

The anal aperture is small but distinct, at the summit of the central cone.

The tube-feet have a very minute, globular, mamelon-like terminal knob.

Colour in alcohol, an ashy white.

Locality.—Station 191. In the Arafura Sea, west of the Arrou Islands. September 23, 1874. Lat. 5° 41′ 0″ S., long. 134° 4′ 30″ E. Depth 800 fathoms. Green mud. Bottom temperature 39°·5 Fahr.; surface temperature 82°·2 Fahr.

Remarks.—In referring this Asterid to the genus *Dytaster* I have felt much hesitation. The examples are small and are probably in an early stage of growth. Their resemblance, however, to the young forms of those species of *Dytaster* with which we are acquainted is sufficiently near to warrant my present decision. The apparently broad border of the marginal plates as seen in the abactinal view, the very small and narrow actinal interradial areas, and the small uniform papilliform granules on the actinal surface of the adambulacral plates at once distinguish the form under notice from all the other species of *Dytaster* in the adult stage. The breadth of the adambulacral plates is relatively greater than in any of the other species in the immature or even in the adult stage. Although it may afterwards be necessary to remove this species to another genus, I consider that the course which I have followed is the best way of indicating what seem to me to be the natural affinities of the species until a larger supply of material is available.

6. *Dytaster biserialis*, n. sp. (Pl. X. figs. 3 and 4; Pl. XIII. figs. 3 and 4).

Rays five. R = 44 mm.; r = 10 mm. R < 4·5 r. Breadth of a ray near the base, 8·5 mm.

Rays elongate, narrow and tapering; of a more or less rigid habit, comparatively thick, subquadrate in section, with vertical lateral walls. Interbrachial arcs widely rounded. Abactinal surface plane and level. Actinal surface of disk convex, prominent at the mouth-angles, and sloping thence to the margin and slightly along the ray.

The paxillæ of the abactinal surface are very small, simple, and crowded, normally composed of four short papilliform or almost granuliform spinelets; often three only are found, and five are but rarely present. They are devoid of a central spinelet or granule. On the outer half of the ray the paxillæ are quite microscopic, more widely spaced, and their simplicity is more evident. On the disk and at the base of the rays a great number of paxillæ are metamorphosed into pedicellariæ, the three or four constituent spinelets being much enlarged, modified in form, and so placed that the tips are brought together, thus forming a large and powerful trivalvate or quadrivalvate pedicellaria. These form a conspicuous feature on the abactinal area, and their distribution amongst the paxillæ is irregular. The pedicle of the paxilla consists of a general tubercular convexity of the plate.

The supero-marginal plates, twenty-eight in number from the median interradial line to the extremity, form a narrow and more or less bevelled margin to the rays, the breadth being less than the height or the length, and the latter dimension is slightly the greatest. The series of plates form a continuous level surface, uninterrupted by individual convexities. Each plate bears a short, conical, but blunt spinelet, little more than an elongate tubercle, placed on the curved part of the plate and directed at an angle outwards. The surface of the plate is covered with very minute, widely spaced conical granules.

The infero-marginal plates correspond exactly to the superior series, each being directly beneath and opposite its companion plate; their line of suture is consequently straight. The breadth on the inner part of the ray is a little greater than the length, but on the outer part the proportions are reversed. Each plate bears a single short spinelet similar in size and character to those on the supero-marginal plates, or perhaps a shade longer; and the surface of the plate is covered with similar minute, conical, widely spaced granules.

The adambulacral plates are long and very narrow, and with the furrow margin only slightly convex. Their armature consists of:—(1.) A furrow series of eight short, cylindrical spinelets, the outermost on each side being shorter than the rest. (2.) Immediately behind the furrow series is a lineal series of six similar but rather smaller spinelets, running parallel to the median line of the ray. On the outer part of the ray the spinelets of both series become extremely short. No other spinelets or granules are present on the plates.

The mouth-plates are large, elongate, narrow, and the united pair are prominently

convex. The median suture is more or less imperfectly closed, and is widely open on the outer part, sometimes partly exposing the odontophore, especially in the young form. The armature consists of a marginal series of nine or ten small, cylindrical, short, spinelets on each plate, the innermost two or three slightly longer and more robust; behind this is an irregular series of very short granuliform spinelets, the innermost, however, being nearly as large as the innermost of the marginal series, with which they form a group at the mouth-angle. The rest of the plate bears a few widely disposed granules, more or less irregular in position, but with a tendency in some cases to form a lineal series; and the surface of the mouth-plate, as a whole, has the appearance of being covered with widely spaced granules.

The actinal interradial areas, though of small dimensions, contain a considerable number of intermediate (or ventral) plates, above fifty being present in each area. These plates are small, with a central, broad, low, but well-defined tubercular convexity, forming a pedicle upon which are borne three or four small spinelets, constituting a very simple paxilla. The plates form a subtransverse lineal series, running from the adambulacral plates to the marginal plates, and four or five plates may be counted in the longest series on each side of the median interradial line. No interradial plates extend beyond the fourth or fifth marginal plate.

The anal aperture is superficially indistinguishable in the material examined.

The madreporiform body is large, compound, and more or less hidden by paxillæ; it is only separated by a narrow space from the margin.

Colour in alcohol, a bleached greyish white.

Young Phase.—A young example, which measures R = 15·5 mm.; $r-4 = 4·5$ mm., is readily recognisable even at this early stage as belonging to the species. The rays, however, have not quite the attenuate character of the adult, for though tapering they have an obtuse appearance, and the terminal plate is large and broad, whilst in the fully grown form it is more elongate. There are fourteen supero-marginal plates, counting from the median interradial line to the extremity; and they form a comparatively broader border on the abactinal surface. The minuteness of the paxillæ on the abactinal surface is remarkable. The anal aperture is distinguishable. The madreporiform body is very near the margin, and a large plate stands on its adcentral side. I have been unable to detect any papulæ. The adambulacral plates are very long and narrow, and their armature is already essentially the same as that of the adult. There are five or six spinelets in the slightly curved furrow series, and a longitudinal series of four or five behind these form a straight line parallel to the furrow. The mouth-plates are remarkably long and narrow. The actinal interradial areas are very small, and not more than ten to twelve minute plates are present in each. The lateral spinelets, or rather their incipient representatives, have a tendency to be placed near the aboral margin of the infero-marginal plates.

Locality.—Station 79. Between the Azores and Madeira. July 11, 1873. Lat.

36° 21′ 0″ N., long. 23° 31′ 0″ W. Depth 2025 fathoms. Globigerina ooze. Bottom temperature 35°·9 Fahr.; surface temperature 71°·5 Fahr.

Remarks.—This species, by reason of its comparatively short and tapering rays, has a somewhat different facies from that of the other members of the genus; and I felt at first some hesitation in placing it along with them. The length and narrowness of the adambulacral plates and the character of their armature show, however, an unmistakable alliance with *Dytaster*. The general characters of the abactinal surface and of the marginal plates also furnish confirmatory support as to this view of its classification. It is for the present undesirable to damage the solitary adult specimen by dissection to ascertain what evidence might be derived from its anatomy. The depth at which this species was dredged is worthy of note (2025 fathoms).

7. *Dytaster inermis*, n. sp. (Pl. X. figs. 5 and 6; Pl. XIII. figs. 5 and 6).

Rays five. $R = 16$ mm.; $r = 5$ mm. $R > 3\,r$. Breadth of a ray between the second and third supero-marginal plates, 4·25 mm.

Rays rather short, broad at the base, and tapering continuously to the extremity. Lateral walls low, and rounded at the junction with the actinal and abactinal surfaces. Interbrachial arcs rather acutely rounded. Abactinal surface plane, sloping slightly from the base to the extremity of the rays. Actinal surface plane.

The paxillæ of the abactinal surface are very small and widely spaced, composed of three to five short, delicate, spinelets of equal length, each with several denticles at the tip. The spinelets radiate very little apart, and form a rather compact paxilla, the base of which is comparatively robust. There is no central spinelet. On the outer part of the rays the paxillæ are very small, with seldom more than three or four spinelets. Near the margin, and at the base of the rays, a number of paxillæ are modified into a comparatively robust, valvate, pedicellarian apparatus.

The supero-marginal plates, fifteen in number from the median interradial line to the extremity, form a narrow but distinct border to the disk and rays, slightly rounded marginally when viewed from above. The plates are small, and their length is slightly greater than their breadth throughout. The height of the plates is less than the length, except in three or four of the innermost plates in the interbrachial arc, in which the height is considerably greater. The surface of the plates appears to have been covered with very minute, short, delicate, microscopic spinelets, widely spaced; but a great number have been abraded, leaving, where this has occurred, a peculiar spongy-looking surface of plate exposed. There are no large spines, nor is any trace of their existence present. The terminal plate is large, slightly swollen laterally at the proximal extremity, and indented for a short distance by the paxillar area in the median radial line.

The infero-marginal plates correspond exactly to the superior series, and their surface is covered with similar widely spaced microscopic spinelets, which have been much

abraded (?). On some of the plates on the inner part of the ray there is a small rudimentary lateral spinelet, which, although much larger than the other spinelets on the plates, is scarcely discernible without a magnifying glass. This does not appear to be present on all the plates, and I find no trace of its existence on the outer part of the ray. In the interbrachial arcs two or three plates bear very large pedicellarian apparatus formed of three or four comparatively long and robust spines. This is usually placed near the junction of the infero-marginal with the supero-marginal plates; and there may occasionally be one similarly placed further out on the ray.

The adambulacral plates are long and very narrow, with the furrow margin very faintly convex. Their armature consists of:—(1.) A furrow series of five or six short, cylindrical, obtusely tipped spinelets, subequal in size, except the outer one of the series, which is sometimes smaller. They appear to stand parallel to one another, forming a compact series, and the successive series are widely spaced apart. (2.) Immediately behind the furrow series, on the actinal surface of the plate, is a lineal series of three or four spinelets precisely similar in size and form, closely appressed to the furrow series; and there are no other spinelets or granules on the adambulacral plates.

The mouth-plates are large and elongate. The pair together are slightly convex actinally, and the median suture is widely open. The armature consists of a marginal series of nine or ten small, short, obtuse, papilliform spinelets on each plate, the innermost one of which is rather larger and more robust than the others. On the actinal surface of the plates are a few irregularly placed papilliform granules, showing to a certain extent a tendency in places to form a second series behind the marginal series; one or two of the papillæ at the anterior end of the plate are larger than the others.

The actinal interradial areas are remarkably small and limited; and there are not more than from four to six very small intermediate plates in each. These plates bear small, isolated, papilliform granules, and there may be two or more pedicellarian apparatus, similar to those described in the interbrachial arcs, in each area.

The tube-feet have a terminal knob, which is large when compared with the small size of the Asterid.

The anal aperture is slightly excentric and difficult to distinguish.

The madreporiform body is rather large, and with very coarse striations, and is situated close to the marginal plates. It is more or less concealed by paxillæ.

Colour in alcohol, clear white.

Locality.—Station 198. In the Celebes Sea, between Celebes and Mindanao. October 20, 1874. Lat. 2° 55′ 0″ N., long. 124° 53′ 0″ E. Depth 2150 fathoms. Blue mud. Bottom temperature 38°·9 Fahr.; surface temperature 85°·0 Fahr.

Remarks.—There seems to me little doubt that this is an immature specimen. Still it is very distinct from any species hitherto known, and its characters have appeared to me sufficiently well-marked to justify its recognition by name. At first sight the marginal

plates appear to form too broad a border on the abactinal surface for this genus; but we find that in the young stages of other species of this genus (*e.g.*, in *Dytaster biserialis* and *Dytaster exilis*) the supero-marginal plates form a definite border in the immature phase, even when they are confined entirely to the lateral wall in the adult. In like manner the very small and limited actinal interradial areas seemed at first to throw doubt upon the correctness of the reference of this example to *Dytaster*, but this again is found to be warranted by the early condition of other species. The character of the adambulacral plates and their armature, the character of the abactinal paxillæ and of the pedicellariæ, accord perfectly with those of *Dytaster*. On these grounds I have placed it in this genus, and consider that it is probably nearly allied to *Dytaster biserialis*.

The form, as we know it at present, is readily distinguished from all the other members of the genus by the unarmed marginal plates, the character of the abactinal paxillæ, and the simple armature of the adambulacral plates.

Genus *Plutonaster*, Sladen.

Plutonaster, Sladen in Narr. Chall. Exp., 1885, vol. i. p. 610.

Disk comparatively large and flat. Rays usually elongate, more or less rigid.

Marginal plates rectangular; the supero-marginal plates thick and massive, forming a well-defined and often broad border on the abactinal surface. The plates of the superior and inferior series directly superposed, contingent horizontal margins straight. The supero-marginal plates usually devoid of spines; the infero-marginal plates frequently with one small rudimentary spine, but even this is sometimes aborted or absent altogether. The general surface of the plates of both series covered with small papilliform granules.

Abactinal area with small closely packed pseudo-paxillæ. No definite medio-radial line of plates. Papulæ generally distributed. Abactinal plates at the sides of the ray arranged in more or less definite obliquely transverse series.

Actinal interradial areas large, with numerous well-defined intermediate (ventral) plates, arranged in regular columns, the breadth of the plates decreasing as they approach the margin.

Armature of the adambulacral plates consisting of:—(1.) A longitudinal furrow series of short, subequal, cylindrical spinelets, sometimes radiating slightly apart. (2.) Two or more longitudinal series of papilliform granules on the actinal surface, the innermost occasionally spiniform. One large conical spinelet may be present on the actinal surface, but frequently only on plates near the extremity of the ray. In some forms (the subgenus *Tethyaster*) the armature of the actinal surface of the adambulacral plates is disposed in a co-ordinated group rather than in definite longitudinal series, and in these cases it is usually more distinctly spiniform in character.

Madreporiform body large, sometimes compound, placed about its own diameter distant from the margin, more or less concealed by paxillæ (except in the subgenus *Tethyaster*).

No pedicellariæ are present.

Anal aperture subcentral.

Actinostome nearly closed by the mouth-plates.

Remarks.—In this genus is included the handsome North-Atlantic form to which Sir Wyville Thomson gave the name of *Archaster bifrons*. It differs in some respects from the majority of species which I place in the genus, especially in the character of the adambulacral armature, and in the spinulation of the plates of the actinal interradial areas. The marginal plates are also more conspicuously armed. In so far, however, as the adambulacral armature is concerned, it will be found to correspond with the earlier stages of the armature in the majority of species of *Plutonaster*, and the characters of which are still exhibited on the plates near the extremity of the ray. After careful study I see no reason for separating this Asterid from the other forms which I have grouped together under the name of *Plutonaster*.

The two starfishes which have long been known under the names of *Astropecten subinermis*, Philippi sp., and *Archaster parelii*, Düben and Koren, are in my opinion very close allies of the present group of species. They exhibit, however, several constant differences which seem to me of a secondary character, and I have therefore placed them in a subgenus (*Tethyaster*) under *Plutonaster*, to which reference will be made on a succeeding page.

Synopsis of the Species included in the Genus Plutonaster *herein described.*

I. Madreporiform body compound, hidden. Adambulacral armature in parallel longitudinal series: granuliform on the actinal surface. Adambulacral plates long and narrow.

A. Supero-marginal plates with a prominent dorsal spine . . . . . *bifrons.*

B. Supero-marginal plates devoid of dorsal spines.

a. Infero-marginal plates armed with a spine. Rays elongate.

a. Large marginal plates. Paxillæ tabulate and compact. No tubercle on the supero-marginal plates. Granulation of the marginal plates truncate and obtuse.

α. Supero-marginal plates broader than the paxillar area. Secondary adambulacral armature with a well-developed row of spinelets; those external in groups on each plate (two or three groups) . . . . . *marginatus.*

β. Supero-marginal plates narrower than the paxillar area. Secondary adambulacral armature all granular, subequal, equidistantly spaced, not grouped . . . . . *rigidus.*

b. Small marginal plates. Paxillæ simple, radiating. Conical tubercle on the supero-marginal plates. Granulation of marginal plates conically pointed . . . . . *ambiguus.*

b. Infero-marginal plates devoid of a spine, or only with a minute rudiment in old age. Rays short and thick.

a. Disk broad, rays narrow . . . . . *notatus.*

b. Disk small, rays broad . . . . . *abbreviatus.*

II. Madreporiform body simple, exposed. Adambulacral armature all spiniform, in co-ordinated groups, subastropectenoid. Adambulacral plates broad. (*Tethyaster.*)
A. Rays long. Marginal plates seventy to eighty in the adult . . . . *subinermis.*
B. Rays short. Marginal plates twenty to thirty in the adult . . . . *parelii.*

Chorology of the Genus Plutonaster.

α. Geographical distribution:—

Atlantic: Five species between the parallels of 75° N. and 10° S.

Plutonaster rigidus and *Plutonaster rigidus*, var. *semiarmata*, off the east coast of the United States of America. *Plutonaster abbreviatus* and *Plutonaster notatus*, in the neighbourhood of the Azores. *Plutonaster bifrons* in the Faeröe Channel, off the coast of Portugal, and off the coast of North America (the latter occurrence on the evidence of a single immature specimen, which might belong to a variety). This species has also been obtained (*fide* Norman[1]) in the Barents Sea between Spitzbergen and Nova Zembla, in lat. 73° 41′ 12″ N., long. 22° 58′ 30″ E., at a depth of 210 fathoms. The examples are stated to be young. *Plutonaster marginatus* in the South Atlantic, near the Island of Ascension.

Pacific: One species between the parallels of 30° and 40° S.

Plutonaster ambiguus, off the east coast of Australia, near Sydney.

β. Bathymetrical range: 210 fathoms to 1360 or 1700[2] fathoms.

All the species except *Plutonaster marginatus* belong exclusively to the abyssal zone. Of the remaining five, two only, *Plutonaster bifrons* and *Plutonaster ambiguus*, have been found in depths less than 1000 fathoms.

Greatest range of one species: *Plutonaster bifrons*, 210 to 1360 fathoms.

γ. Nature of the Sea-bottom: Two species, *Plutonaster rigidus* and *Plutonaster bifrons*, are found on the Blue mud, and *Plutonaster bifrons* is also found on Globigerina ooze. *Plutonaster ambiguus* is found on Green mud. *Plutonaster notatus* is found on Pteropod ooze; the nearly allied *Plutonaster abbreviatus* on Volcanic mud. *Plutonaster marginatus* on Volcanic sand.

[1] In W. S. M. D'Urban on the Zoology of Barents Sea, *Ann. and Mag. Nat. Hist.*, ser. 5, vol. vi., 1880, p. 260.

[2] The uncertainty in the limit of greatest depth arises from not knowing at which of two stations *Plutonaster rigidus* was dredged.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Plutonaster abbreviatus . .	N. Atlantic.	1000 .	Volcanic mud.
Plutonaster ambiguus . . .	S. Pacific.	950	Green mud.
Plutonaster bifrons . . .	N. Atlantic.	210 to 1360	Globigerina ooze. Blue mud (1340 fathoms).
Plutonaster marginatus . .	S. Atlantic.	425	Volcanic sand.
Plutonaster notatus . . .	N. Atlantic.	1000	Pteropod ooze.
Plutonaster rigidus . . .	N. Atlantic.	1700 or 1240[1]	Blue mud.
Plutonaster rigidus, var. *semiarmata*	N. Atlantic.	1340 or 1350[1]	Blue mud.

1. *Plutonaster bifrons*, Wyville Thomson, sp. (Pl. XI. figs. 1–4; Pl. XIII. figs. 9 and 10).

Archaster bifrons, Wyville Thomson, 1873, The Depths of the Sea, p. 122, figs. 17 and 74.

Rays five. $R = 90$ mm.; $r = 21$ mm. $R < 4{\cdot}5r$. Minor radial proportion 23·3 per cent. Breadth of a ray near the base, 25 mm.

Rays elongate, moderately broad at the base, tapering continuously to a finely pointed extremity. Interbrachial arcs widely rounded. Lateral walls vertical. Abactinal surface plane, or slightly inflated. Actinal surface subplane, highest at the mouth-angles, and sloping thence to the margin and along the rays.

The paxillæ of the abactinal surface are minute and crowded; and are composed of twenty to twenty-five short papilliform spinelets—five or six in the midst of each crown being more robust than the rest.

The marginal plates are large, well-defined, and conspicuous. The supero-marginal plates, thirty-three in number from the median interradial line to the extremity, form a well-defined border on the abactinal surface. They are about as broad as high, and covered with granules, which become subconical in form on the lateral half of the plate. Each supero-marginal plate bears a single, moderately long, conical pointed spinelet, which stands on the rounded angle of the plate, and is directed outward almost horizontally. Sometimes this spinelet may be redoubled on two or three plates near the middle of the ray. The sutures between the plates are well-defined.

The infero-marginal plates correspond to the superior series, and are similar in every respect, covered with similar subconical granules, and each with a similar and equal-sized spinelet directed horizontally. The supero-marginal spines diminish in size towards the interbrachial arc and towards the extremity, and also the infero-marginal spines, but in a less degree. The largest spines are consequently about midway on the ray.

[1] The exact station is not known: an alternative record being given.

The adambulacral plates form a straight or very faintly festooned margin to the furrow. Their armature consists of—(1.) A furrow series of nine or ten rather elongate spinelets, which are slightly compressed, not tapering, and with rounded extremities. The middle spines are largest, and those at the end of the series diminish by gradation, the outermost being small and setiform. The spinelets form straight series, and stand almost parallel to one another, radiating very slightly. (2.) On the actinal surface of the plate, behind the furrow series, stands a single large, conical, sharply pointed spinelet, nearly as large and robust as the lateral spines. There are a few minute setiform spinelets irregularly disposed on the actinal surface of the plate on each side of the large spine and along the outer margin of the plate.

The mouth-plates are large, and the united pair are prominently convex actinally, forming a rather low but well-defined elliptical-shaped tumidity. Their armature consists of a marginal series of ten to twelve short mouth-spines on each plate. These increase slightly in length as they proceed inwards, and the longest are not greater than the largest spines in the furrow series of the adambulacral plates. The actinal surface of the plate is covered with numerous short, papilliform spinelets, which increase in size and robustness at the inner end of the plates, those at the extremity being quite equal in length to the marginal series and even slightly more robust. These larger spinelets are crowded at the extremity. There is no representative on the mouth-plates of the large isolated secondary spine on the actinal surface of the adambulacral plates.

The actinal interradial areas are large. The intermediate or ventral plates, which are small, numerous, and regularly quadrate, are arranged in lineal series or columns extending from the adambulacral plates to the marginal plates—the breadth of the columns at their inner extremity corresponding to the length of the adambulacral plates, but contracting as they proceed outward, in consequence of the diminution of the size of the plates. The intermediate plates are covered with papilliform granules or spinelets, and each of those in the area of the disk bears a single, moderately robust, conical pointed spinelet, springing from the midst.

The anal aperture is subcentral and distinct.

The madreporiform body is obscured by paxillæ, and these being more widely spaced in its vicinity indicate the position of the body, which is rather nearer the margin than midway between the centre and the margin.

The terminal (ocular) plate is minute.

The tube-feet are conical, with a very minute, conical, mamelon-like termination, and there is no sucker-disk.

Colour in alcohol, a bleached ashy-grey, and often with a more or less ochraceous shade on the actinal interradial areas.

Young Phase.—In its early stages this species has a very different appearance from that presented by the adult, the rays being short and triangular, and the marginal con-

tour little more than stellato-pentagonal. The smallest example I have seen measures R = 4·5 mm., $r = 2·5$ mm., and has six supero-marginal plates, and seven infero-marginal plates. These are all broader than long, and there is as yet no trace of the "dorsal" spine on the supero-marginal plates. At the extremity of the odd terminal plate there is a single tapering pointed spine standing on the median radial line, and directed outward; and one on each side at a lower level. The infero-marginal plates bear a well-developed lateral spine, which is comparatively robust and pointed. The adambulacral plates, which are long and narrow, have a marginal series of spinelets which radiate over the furrow, about five in number near the mouth, but not more than three near the extremity; external to these, on the actinal surface of the plate, is a lineal series of three or four papilliform granules, equal sized. There is no large conical spine on the actinal surface of the plate, but near the extremity of the ray the aboral spinelet of the marginal series is much larger than the others. The mouth-plates are elongate and ploughshare-shaped; the suture between the two plates of a pair is not closed; and the odontophore is exposed. There are at least eight intermediate plates in each actinal interradial area, three on each side of the median interradial line, each of which touches the marginal plates, and a fourth intervenes between the innermost of the three and the mouth-plates. These plates bear small, equal, papilliform granules.

At a little older stage, when the measurements are R=7·5 mm., $r=3$ mm., there are nine supero-marginal plates and ten infero-marginal plates, and the supero-marginal plates bear a low conical papilla—the rudiment of the future dorsal spine. The characters of the adambulacral plates, mouth-plates, and intermediate plates are essentially the same as described above. On two or three of the innermost adambulacral plates there are indications of the future prominent large conical spine on the actinal surface, but on the outer part of the ray the large spine is in the marginal series and at the aboral end. There are twelve or fourteen plates in the actinal interradial areas.

When the measurements are R = 11 mm., $r = 4$ mm., there are fourteen supero-marginal plates, and, excepting the greater length of the ray and the increase in the number of plates in the actinal interradial area (at least twenty-four being present), there is not a great change from the characters noted in the preceding stage.

When a little larger, with the radial proportions of R = 12·5 mm., $r = 4·25$ mm., and fifteen supero-marginal plates are present, the adambulacral plates are distinctly beginning to assume the characters of the adult form. The large conical spine is well-developed, although it does not yet occupy the central position on the actinal surface.

When the young Asterid has attained the dimensions of R = 18 mm., and $r = 5·25$ mm., its characters are sufficiently marked to leave little if any doubt as to the species, if such a specimen were dredged singly.

With a major radial dimension of 41 mm. and $r = 10$ mm. there is still no trace of the central conical spine on the plates of the actinal interradial areas in a specimen from

this station off the coast of Portugal. But they are strongly developed in a specimen measuring R = 63 mm., which has twenty-eight supero-marginal plates. It is further to be noticed that in the last-named example the large widely spaced granules on the median area of the infero-marginal plates are for the first time conspicuous ; all the papilliform granules being more or less subequal in size and in distance apart in the earlier stages. The tube-feet have a small but distinct terminal knob.

Locational Variation.—In a series of specimens dredged by H.M.S. "Triton" (Station 11) there are distinct indications of the central conical spinelet on the actinal interradial plates when R = 37 mm. and $r = 10{\cdot}5$ mm. The rays are also less attenuate and broader at the base, and the disk is larger than in the example from the more southern station. There are twenty-five supero-marginal plates, and their length is rather less than in the example mentioned above which measures R = 41 mm., the number of plates being the same in both. The adult specimens from this locality appear to have generally a larger disk than other examples which I have examined.

Localities.—Challenger Expedition :

Station off the coast of Portugal, January 1873. (Exact date and locality not given. The label accompanying the specimens is simply marked, "Off coast of Portugal, Stn. I. to VII." On referring to Sir Wyville Thomson's Voyage of the Challenger, The Atlantic, vol. i. p. 132, *et seq.*, I infer from the context that these examples were probably taken at Station V.)

Station V. South of Cape St Vincent. January 28, 1873. Lat. 35° 47′ 0″ N., long. 8′ 23′ 0″ W. Depth 1090 fathoms. Globigerina ooze. Bottom temperature 38°·5 Fahr. ; surface temperature 61°·0 Fahr.

Station 47. Off the coast of North America, east of Massachusetts. May 7, 1873. Lat. 41° 14′ 0″ N., long. 65° 45′ 0″ W. Depth 1340 fathoms. Blue mud. Surface temperature 42°·0 Fahr. A young example of this (?) species. (See remarks below.)

"Porcupine" Expedition :

Station 19. West of Donegal Bay. Lat. 54° 53′ N., long. 10° 56′ W. Depth 1360 fathoms. Bottom temperature 3°·0 C. ; surface temperature 12°·6 C.

Station 57.[1] In the Faeröe Channel. Lat. 60° 14′ N., long. 6° 17′ W. Depth 632 fathoms. Bottom temperature 0°·8 C. ; surface temperature 11°·1 C.

Station 58.[1] In the Faeröe Channel. Lat. 60° 21′ N., long. 6° 51′ W. Depth 540 fathoms. Bottom temperature 0°·6 C. ; surface temperature 10°·6 C.

"Knight Errant" Expedition :

Station 8. In the Faeröe Channel. August 17, 1880. Lat. 60° 3′ N., long. 5° 51′ W. Depth 540 fathoms. Ooze. Bottom temperature 29°·2 Fahr. ; surface temperature 56°·5 Fahr.

[1] These occurrences are cited in Sir Wyville Thomson's Depths of the Sea. I have not seen the specimens.

"Triton" Expedition:

Station 10. In the Faeröe Channel. August 24, 1882. Lat. 59° 40′ N., long. 7° 21′ W. Depth 516 fathoms. Bottom temperature 46° Fahr.

Station 11. In the Faeröe Channel. August 28, 1882. Lat. 59° 29′ N., long. 7° 13′ W. Depth 555 fathoms. Bottom temperature 45°·5 Fahr.

Remarks.—This species is readily recognised by the well-developed spines on the supero-marginal plates and the central conical spine on the intermediate or ventral plates in the actinal interradial areas.

1*a*. (?) *Plutonaster bifrons*, Wyville Thomson, sp., juv.

There is a single small example from Station 47A, about which I feel some doubt. It is an immature specimen measuring R = 12·5 mm., $r = 5$ mm., and there are fourteen supero-marginal plates. Excepting that the rays are broader at the base and less attenuate, and that the disk is larger, this juvenile accords so closely in all particulars of detail with a similar sized specimen of *Plutonaster bifrons*, that if it does not actually belong to the type-form of that species there need be little hesitation in regarding it as the young of a very nearly related variety. I cannot think that it is a distinct species. As the adult form has not to my knowledge been met with hitherto in the North-American region, further material is obviously necessary before anything definite can be arrived at with respect to this immature specimen. I have remarked on broad-disked specimens (shown both in the young and fully grown state) dredged by the "Triton," but have seen no reason to give a name to the variety.

2. *Plutonaster marginatus*, n. sp. (Pl. XIV. figs. 1 and 2; Pl. XV. figs. 1 and 2).

Rays five. R = 57 mm.; $r = 16·5$ mm. $R < 3·5\,r$. Breadth of a ray between the third and fourth supero-marginal plates, 13 mm.; midway along the ray, 8 mm.

Rays moderately elongate, rather broad at the base, and tapering towards the extremity, which is attenuate. Depressed and comparatively flat, rather thin, and angularly rounded laterally. Interbrachial arcs wide and well-rounded. Disk rather large; abactinal paxillar area slightly below the level of the marginal plates, probably capable of some inflation. Abactinal surface slightly conically convex centrally; with a sharp and abrupt median carination along the inner part of the ray. Actinal surface subplane. General form rather thin and depressed.

The abactinal surface of the disk and rays is covered with numerous, rather small, closely crowded, and uniform paxillæ. These have a broad tabulum, upon which are borne twelve to twenty (about fifteen most usually) low and only slightly papilliform, rather large, granules, five or six being central and slightly larger than the surrounding

circlet. In the central region of the disk, along the median radial line, and upon the whole of the outer two-thirds or more of the rays, no order of arrangement is discernible. In the abactinal interradial areas, on the region adjacent to the marginal plates, the paxillæ are disposed in regular lineal series, the lines of which, if produced beyond the margin, would meet at a point in the prolongation of the median interradial line. Eight or nine paxillæ may be counted in the series adjacent to the median interradial line, and the paxillæ in each series decrease slightly in size as they approach the margin. This arrangement extends only a very short distance outward beyond the base of the rays.

The supero-marginal plates, twenty-three or twenty-four in number from the median interradial line to the extremity, are large, and form a broad and very conspicuous margin to the disk and rays. On the innermost plates in the interbrachial arc the breadth is more than twice the length, but gradually diminishes until these dimensions are subequal, a proportion which is then maintained throughout the ray. The width of the paxillar area midway along the ray is slightly less than the breadth of the supero-marginal plate. The outer surface of the plate is regularly curved or arched, and forms a slightly bevelled rounding to the abactinal area; and on the inner part of the ray there is also a trace of a median convexity along the breadth of the plate. The supero-marginal plates bear no spines, but their surface is covered with very numerous small granules, uniform throughout, which, though closely crowded, do not touch one another. The suture-lines between successive plates are well defined by a distinct channel; and this in the interbrachial arc is rather deep and emphasised by the convexity of the plates.

The infero-marginal plates correspond exactly to the supero-marginal series, and their length is the same; their height in the lateral view is slightly greater than the length in the inner part of the interbrachial arc, but speedily becomes less than the length, the proportion being about two-thirds midway along the ray and outwards. Their breadth on the actinal surface is more than twice the length on the innermost plates in the interbrachial arc, but gradually diminishes along the ray, until the dimensions become subequal near the extremity. The rounding of the plates externally is rather sharp and abrupt, and the infero-marginal plates are a shade more prominent than the superior series, which causes them to be just visible when the starfish is viewed from above. Each plate bears a single, short, robust, conical spinelet, about a millimetre in length, which is placed on the rounding, centrally between the adoral and aboral margins of the plate in the interbrachial arc, but gradually travels nearer to the aboral margin as the plates proceed along the ray. The surface of the plate is covered with numerous, very small, uniform granules, similar to those on the supero-marginal plates; and the suture lines between the successive plates are well defined by channels.

The adambulacral plates are longer than broad, and have the furrow margin slightly convex. Their armature consists of:—(1.) A furrow series of seven or eight short, cylindrical, faintly clavate, spinelets; the outermost at each extremity of the series smaller

than the rest, which are subequal in length. When standing upright they are parallel to one another, and when directed over the very narrow ambulacral furrow, radiate only to a slight degree, often not at all. The succeeding combs thus formed are distinctly spaced. (2.) On the actinal surface of the plate is borne a lineal series of three or four subclavate or subfusiform, papilliform, spinelets, parallel to and close behind the furrow series. These are more robust, but slightly shorter, than the marginal series, and are well spaced apart. External to these, and with a well-defined space between, are two irregular series of short, robust, obtuse, papilliform granules, which have a tendency to associate themselves into groups of three or four, suggestive (but probably nothing more) of incipient pedicellariæ. Occasionally on the larger plates one or two supplementary thornlets or papilliform granules may be present between these groups and the papilliform series of spinelets next to the marginal series. On the outer fourth of the ray the adambulacral plates bear a single conical-pointed spinelet, external to the furrow series, which increases in size as the extremity is approached. No trace of this spine is found on the plates along the inner part of the ray.

The mouth-plates are small and narrow; the united pair have an elongate elliptical outline, and are slightly convex actinally. Nearly half their length is free and protrudes over the actinostome, which they can completely close in. Their armature consists of a marginal series of nine or ten, or more, short papilliform mouth-spines on each plate, which decrease in length as they recede from the mouth, and stand upright and parallel to one another on the free margin. The actinal surface of the plate is covered with numerous papilliform granules which increase in length and robustness as they approach the inner extremity, where they are very robust and definitely papilliform, even longer than the marginal series of true mouth-spines.

The actinal interradial areas are large and well-developed, and intermediate plates extend up to nearly half the length of the ray, the outer ones, however, being very narrow and long. The areas are occupied by well-defined plates arranged in regular series or columns, extending from the adambulacral to the marginal plates. The innermost plate of each series is normally subequal in breadth to the adjacent adambulacral plate, and the columns diminish in breadth as they proceed towards the margin; but the columns generally increase in breadth as they proceed along the ray, whilst their length diminishes *pari passu*, hence the narrow band-like plates on the outer part of the actinal area noticed above. The surface of the plates is covered with numerous small papilliform granules, nearly similar to those on the actinal surface of the adambulacral plates, disposed in regular subrectangular groups, each group marked out from its neighbours by distinct channels, and indicating conspicuously the regularity of the arrangement of the plates. There is usually on each plate a group of three or four papilliform granules slightly larger than the others, simulating an incipient pedicellaria, similar to those mentioned on the adambulacral plates; and in some cases two such groups are present.

The anal aperture is subcentral and large, but no modification occurs in the surrounding paxillæ.

The madreporiform body is entirely obscured by paxillæ, a group of five or six larger than any of the others marking its position, which is rather nearer the marginal plates than midway between them and the centre of the disc. The madreporiform body is of large size; and appearances lead to the inference that it is compound.

The ambulacral tube-feet are conical, with a very small mamelon-like termination.

Colour in alcohol, a bleached ashy white, rather darker and greyish on the paxillar area.

Locality.—Station 343. South-west of the Island of Ascension. March 27, 1876. Lat. 8° 3′ 0″ S., long. 14° 27′ 0″ W. Depth 425 fathoms. Volcanic sand. Bottom temperature 40°·3 Fahr.; surface temperature 80°·8 Fahr.

Remarks.—This species is readily distinguished by its broad supero-marginal plates, and by the row of well-developed spinelets on the actinal surface of the adambulacral plates, immediately behind the furrow series; as well as by the incipient grouping of the outer granules on the actinal surface of the plate.

3. *Plutonaster rigidus*, n. sp. (Pl. XIV. figs. 3 and 4; Pl. XV. figs. 3 and 4).

Rays five. R = 80 mm.; r = 21 mm. R < 4 r. Breadth of a ray between the fourth and fifth supero-marginal plates, 16 mm.; midway along the ray, 9·75 mm.

Rays elongate and rather narrow, tapering from the base to the extremity. Interbrachial arcs very open, with a wide well-rounded curvature. Rays depressed and flat, lateral walls nearly equally rounded abactinally and actinally. Disk comparatively large. Abactinal and actinal surfaces subplane, the latter slightly prominent at the mouth-angles. Abactinal surface faintly carinate along the median radial line. The general form has consequently a flat appearance and is of nearly uniform thickness throughout, excepting towards the end of the rays.

The abactinal surface of the disk and rays is covered with numerous, rather small, compact, closely crowded, uniform paxillæ. These bear on a low broad tabulum from ten to twenty papilliform granules, two to five or sometimes even more being central. Although closely crowded the individual paxillæ may be more or less clearly distinguished. In the central region of the disk, along the median radial line, and upon the whole of the outer two-thirds of the rays, no order of arrangement is discernible. In the abactinal interradial areas, on a region adjacent to the marginal plates, the paxillæ are disposed in lineal series, the lines of which if produced beyond the margin would meet at a point in the prolongation of the median interradial line. These series do not extend far along the basal portion of the ray, and gradually diminish in length as they recede from the median interradial line.

The supero-marginal plates, thirty-one in number from the median interradial line to the extremity, are rather large, and form a conspicuous and well-rounded border to the

disk and rays. When viewed from above, their breadth on the abactinal surface is subequal to their length, slightly greater in the interbrachial arc, and slightly less at the extremity of the ray. Viewed laterally, the height is rather greater than the length in the interbrachial arc, but gradually diminishes until on the outer part of the ray it is rather less than the length. The width of the paxillar area midway along the ray is a shade more than twice the breadth of the marginal plates. The outer surface of the supero-marginal plates is a well-rounded uniform curve without any tumidity, and the series of the plates consequently forms a flush surface. The supero-marginal plates bear no spines, but their surface is covered with rather large uniform hemispherical granules, which are crowded but not touching. These become much smaller and subpapilliform at the extreme adoral and aboral margins. The suture-lines between the plates are thus well defined.

The infero-marginal plates correspond exactly to the superior series, and their length is the same. The height is rather less than the length throughout the ray, excepting on a few plates in the interbrachial arc. Their breadth on the actinal surface is greater than the length in the interbrachial arc, midway along the ray subequal, and at the extremity rather less than the length. The rounding of the plates is rather sharper and more acute than that of the superior series. Each plate bears a short, robust, conical spinelet, the longest about 1·5 mm. in length, placed on the rounding, directed horizontally, and pointed at a slight angle towards the extremity. Along the greater portion of the length this spinelet is placed close to the aboral suture of its plate. The surface of the plate is covered with hemispherical granules similar to those on the supero-marginal plates, closely placed but not touching, with a much smaller and more crowded series along the lines of suture between succeeding plates.

The adambulacral plates are longer than broad, with the furrow margin slightly convex. Their armature consists of:—(1.) A furrow series of nine short, cylindrical, obtusely tipped spinelets, with a tendency to become prismatic, the outermost at each extremity of the series very much smaller than the rest, which are subequal in length. They stand upright and parallel to one another; and the ambulacral furrow is very contracted. (2.) On the actinal surface the plate is covered with low papilliform granules, of which three or more irregular longitudinal series may be indistinctly defined. These are, however, too irregular in their position to be spoken of as forming true series. In apparent size, as viewed from above, they correspond exactly to the granules on the infero-marginal plates, but are, however, slightly more papilliform. The adambulacral plates on the outer fourth of the ray bear a single small conical spinelet immediately behind the furrow series, placed near the aboral margin of the plate, and scarcely noticeable except with a magnifying glass. No trace of this is found along the inner part of the ray.

The mouth-plates are not remarkably large, and the united pair are elongate and elliptical in outline, and slightly convex actinally. Nearly half their length is free and

protrudes over the actinostome, which is contracted and nearly closed. Their armature consists of a marginal series of about nine short papilliform spinelets on each plate, nearly subequal in length, the outermost being slightly smaller, standing upright and parallel to one another. The actinal surface of the plate is covered with numerous rather broad granuliform papillæ, truly granules on the outer portion of the plates, but becoming longer and more papilliform as they approach the inner end of the mouth-angle, the innermost three or four being nearly as long as, and more robust than, the marginal series. All are very obtusely tipped.

The actinal interradial areas are large and well-developed, extending as far as the twelfth or thirteenth adambulacral plate. They are occupied by well-defined plates arranged in regular series or columns extending from the adambulacral plates to the infero-marginal plates. The innermost plate of each series is normally subequal in breadth to the adjacent adambulacral plate, and the columns diminish in breadth as they proceed towards the margin. Seven plates may be counted in the series on each side of the median interradial line. The surface of the plates is covered with closely placed hemispherical granules of similar size and character to those on the adambulacral and marginal plates, disposed in regular subrectangular groups, each group being marked out by distinct and well-defined sutures or channels from those adjacent. The regularity of the arrangement is constant and very conspicuous.

The anal aperture is subcentral, and, though comparatively large, is inconspicuous, as there is no modification in the character of the surrounding paxillæ.

The madreporiform body is entirely obscured by paxillæ, a group of five or six in this region being larger and slightly more prominent than any of the others. These indicate its position, which is rather nearer the margin than midway between the centre and the interbrachial arc. It is possible that the madreporiform body may be of large size or even compound, judging from appearances; but these remarks are purely conjectural, as the fact cannot be decided without damaging the specimen.

The ambulacral tube-feet are large and conical, with a very small, mamelon-like, conical termination.

Colour in alcohol, a very light drab, with an ashy grey shade of the same on the paxillar area.

Locality.—Station 44 or 45. Off the coast of North America, east of Delaware and Maryland.

Station 44. May 2, 1873. Lat. 37° 25′ 0″ N., long. 71° 40′ 0″ W. Depth 1700 fathoms. Blue mud. Bottom temperature 36°·2 Fahr.; surface temperature 56°·5 Fahr.

Station 45. May 3, 1873. Lat. 38° 34′ 0″ N., long. 72° 10′ 0″ W. Depth 1240 fathoms. Blue mud. Bottom temperature 37°·2 Fahr.; surface temperature 49°·5 Fahr.

Remarks.—*Plutonaster rigidus* is distinguished from *Plutonaster ambiguus* by its larger size, by the large marginal plates, by the absence of a prominent tubercle on the

supero-marginal plates, and by the truncate and obtuse granulation on the marginal plates. The presence of the short, though well-developed, spinelet on the infero-marginal plates, as well as the general form and size of the starfish, prevents its being mistaken for *Plutonaster notatus*. The differences that characterise *Plutonaster marginatus* are sufficient to avoid any clashing with that form.

3*a*. *Plutonaster rigidus*, var. *semiarmata*, nov. (Pl. XIV. fig. 5).

Rays five. R = 84 mm. ; r = 20 mm. Breadth of the ray between the fourth and fifth supero-marginal plates, 15 mm. ; midway along the ray, 9 mm.

From Station 46 or 47 a variety of *Plutonaster rigidus* was obtained, the characters of which are so well marked that its recognition by name seems desirable. This form differs most conspicuously from the type in that the infero-marginal plates in the interbrachial arc along the disk are devoid of the conical spinelets, although these are present from the base of the ray outwards as usual. The marginal plates both of the inferior and superior series are peculiar in being covered centrally with a membrane through which the granules can be faintly seen. This membrane does not cover the extreme margins at the adoral and aboral sutures, but leaves exposed the cilia-like papilliform granules there. The plates are slightly concave in their median line of breadth, at least in the interbrachial arc and at the basal part of the rays, and the presence of the membrane gives them at first sight a naked appearance, which is further emphasised by the visibility of the marginal cilia. This character is less striking on the outer part of the rays, probably in consequence of the membrane being thinner there. The granules which cover the plate underneath the membrane are smaller than in the type.

The paxillæ on the abactinal surface are slightly larger than in the type, with more numerous granules on the central tabulum, and with more numerous but comparatively smaller papilliform granules in the marginal series which surround them. Thus there may be as many as from nine to twelve in the centre, and about twenty in the marginal series, the disparity in size being conspicuous ; and the central area of granules often appear faintly convex.

The disc is a trifle smaller and the rays slightly longer and narrower ; but the difference in this respect is not very important.

The granules on the actinal surface of the adambulacral plates are perhaps slightly smaller, more numerous, and even less regular than in the type. The intermediate plates of the actinal interradial areas are similar to those in the type, and neither they nor the adambulacral plates have any superficial membranous covering.

Colour in alcohol, a bleached white, ashy grey on the paxillar area, and a light brownish shade on the actinal surface.

Locality.—Station 46 or 47. Off the coast of North America, east of New Jersey and Long Island.

Station 46. May 6, 1873. Lat. 40° 17′ 0″ N., long. 66° 48′ 0″ W. Depth 1350 fathoms. Blue mud. Bottom temperature 37°·2 Fahr.; surface temperature 40°·0 Fahr.

Station 47. May 7, 1873. Lat. 41° 14′ 0″ N., long. 65° 45′ 0″ W. Depth 1340 fathoms. Blue mud. Surface temperature 42°·0 Fahr.

4. *Plutonaster ambiguus*, n. sp. (Pl. XI. figs. 5 and 6; Pl. XIII. figs. 11 and 12).

Rays five. R = 25 mm.; $r = 6{\cdot}5$ mm. $R < 4r$. Breadth of a ray near the base, 6·5 mm.

Rays narrow and pointed, tapering throughout from the base. General form thin and subdepressed, with the abactinal surface slightly inflated along the median radial lines, forming a more or less definite keel. Actinal surface subplane, prominent at the mouth-angles; and sloping thence to the margin and slightly along the ray. Interbrachial arcs widely rounded.

The paxillæ of the abactinal surface are very minute and crowded; each with a crown of five or six small, equal, papilliform spinelets, almost subclavate in form, which radiate outward. The paxillæ diminish in size as they proceed along the ray, and simpler ones are frequent on the outer half.

The supero-marginal plates, twenty-eight to thirty in number from the median interradial line to the extremity, are very small and slightly tumid; they form a well-rounded lateral wall to the disk and rays; and when viewed abactinally present a narrow but definite border. The length of the plates is greater than their height throughout the series, and their breadth is subequal to, or slightly greater than, their length on the inner part of the ray, but gradually becomes slightly less than the length on the outer part. The surface of the plate is covered with small, well-spaced papilliform granules, and one small tubercle-like granule, larger and more robust than the rest, is placed on the rounding of the plate, and represents a supero-marginal spine. This tubercle-like granule is, however, scarcely distinguishable from the rest of the covering of the plate on the outer part of the ray, and it is doubtful whether it extends to the extremity.

The infero-marginal plates correspond to the superior series, but their breadth is fully twice as great as their length on the inner part of the ray, and subequal on the outer part. Their surface is covered with minute conical thornlets of about the same general size and distance apart as the rounded granules on the supero-marginal plates. Each plate bears one short, tapering, pointed, spinelet, not more than a millimetre in length, directed horizontally outward. Their length diminishes along the ray, and I am unable to speak of their character or presence at the extremity.

The adambulacral plates are longer than broad, and of a subrhomboid form, with a slightly convex margin towards the furrow. Their armature consists of:—(1.) A furrow

series of six or seven delicate, tapering, sharply-pointed spinelets, arranged on the margin of the plate, and radiating apart horizontally over the furrow; the two or three median spinelets being the longest, and the outermost on each side less than one-third their length. (2.) On the surface of the plate is a lineal series of three or four small spinelets, running parallel to the median line of the ray and close behind the furrow series; one of these is comparatively elongate, tapering, and robust, whilst the others are mere papilliform granules, irregularly spaced. On the outer margin of the plate a lineal series of miliary thornlets may be present.

The mouth-plates are very elongate and narrow, the united pair being slightly convex. The median suture is imperfectly closed; the inner margin at the outer extremity of each plate is rounded, and a spiniferous plate is visible in the space thus formed. The free margin of each plate bears an armature of seven or eight very short, robust, obtuse and slightly flattened mouth-spines, the innermost of which is the largest. On the surface of the plate five or six papilliform spinelets form a short, closely-placed series, parallel to the median suture, which does not extend along more than half the length of the plate, and the spinelets diminish in length as they recede from the mouth. The rest of the surface of the plate bears small papilliform granules widely spaced.

The actinal interradial areas are extensive as compared with the small size of the starfish, and are occupied by a large number of regularly disposed intermediate plates. The plates are arranged in regular transverse series, which proceed from the adambulacral plates to the marginal plates; those adjacent to the adambulacral plate are subequal in their major dimension to its length, but succeeding plates in a column diminish in length as they proceed outward, and each plate imbricates slightly upon its predecessor. Five or six plates may be counted in the column or series adjacent to the median interradial line, and the number in a series decreases gradually as they proceed along the ray, the innermost plate (that adjacent to the adambulacral) alone being present at last; these extend as far as the seventh marginal plate, which is thus separated from the tenth adambulacral plate; beyond this the adambulacral and marginal plates are contingent. The surface of the plates is covered with numerous short, uniform, papilliform, spinelets, rather widely spaced; and their arrangement does not in any way simulate a paxilla. The individuality of the plates is clearly defined, and the regularity of their disposition is conspicuous.

An anal aperture appears to be present in a subcentral position, but is very indistinct.

The madreporiform body is little more than its own diameter distant from the margin, is hidden by paxillæ, and superficially invisible.

Colour in alcohol, a dirty ashy grey-white, with traces of a light brown shade on the paxillar area.

Locality.—Station 164. East of Sydney, New South Wales. June 12, 1874. Lat.

34° 8′ 0″ S., long. 152° 0′ 0″ E. Depth 950 fathoms. Green mud. Bottom temperature 36°·5 Fahr.; surface temperature 69°·5 Fahr.

Remarks.—This is a very characteristic form, and distinguished from all other species by the small marginal plates, the well-developed infero-marginal spines, the conical tubercle on the supero-marginal plates, the conically-pointed granulation of the marginal plates, and the simple radiating paxillæ.

5. *Plutonaster notatus*, n. sp. (Pl. XIV. figs. 6 and 7; Pl. XV. figs. 5 and 6).

Rays five. R = 31·5 mm.; r = 10·75 mm. R < 3 r. Breadth of a ray at the fifth supero-marginal plate, 5·5 mm.; midway along the ray, 4·5 mm.

Rays short, very narrow, and slightly tapering; the wide and open interbrachial arcs emphasising their narrowness, as well as the pentagonal character of the disk from whence they proceed. Nearly square in section, with the angles slightly rounded. Disk comparatively large. Abactinal surface of the disk slightly convex and inflated; that of the rays being flat. Actinal surface of the disk very slightly convex, subplane along the rays.

The abactinal surface of the disk and rays is covered with numerous small paxillæ, composed of short, cylindrical, obtusely tipped, equal spinelets, standing upright and forming compact little groups of uniform height, with seven to fifteen spinelets in each, two to four being central and usually slightly more robust than the others. Though crowded, the paxillæ are so spaced that each remains distinct; upon the central area of the disk no order of arrangement is discernible, but near the marginal plates they are disposed in lineal series running towards the marginal plates. The series on each side of the median interradial line are parallel thereto; and as each succeeding series converges slightly, their position at the base of the ray is obliquely transverse to its axis; in other words, if the lines of these lineal series were produced, they would meet at a common point outside the margin in the prolongation of the median interradial line. This arrangement does not extend beyond the base of the rays; outward along the rays the paxillæ present no definite order of arrangement, nor yet upon the median radial line throughout, nor on the whole central area of the disk, as above noticed. No pedicellariæ are present.

The supero-marginal plates, twenty-two to twenty-four in number from the median interradial line to the extremity, are small, but form a distinct and regular border to the disk and rays. When viewed from above their breadth on the abactinal surface is slightly greater than their length; and when viewed laterally the height is subequal to the length along the greater portion of the ray, but increases in the interbrachial arc, where the plates have a smaller abactinal bending. Midway along the ray, the breadth of the supero-marginal plates is nearly as great as the width of the paxillar area. The union of the abactinal and lateral planes of the plates is well rounded. The supero-marginal plates bear no spines, but their surface is covered with tolerably large, uniform, hemispherical,

or subpapilliform granules, except at the adoral and aboral margins, where they become more or less cilia-like. The suture-lines between the plates are well defined.

The infero-marginal plates correspond exactly to the superior series, their line of union being perfectly horizontal. About midway along the ray the height is subequal to the length, but increases in proportion in the inner part of the interbrachial arc, and decreases at the extremity of the ray. The breadth on the actinal surface is subequal to the length, excepting at the base of the ray and along the interbrachial arc, where it is greater than the length. The union of the actinal and lateral planes is well rounded. Each plate normally bears a single, very minute, conical thornlet, on the rounded angle; within the interbrachial arc these are placed centrally, but along the ray, where they are greatly reduced in size, they stand nearer the aboral margin of their plate, and they point towards the extremity of the ray at so acute an angle as almost to appear appressed to the lateral wall. Furthermore they are so small as only to be noticeable with the aid of a magnifying glass. The longest, which are in the interbrachial arc, are little more than half a millimetre in length. The surface of the plate is covered with rather large hemispherical granules distinctly spaced, which become subpapilliform or cilia-like and crowded at the adoral and aboral margins. The sutures between the plates are well defined; and those in the interbrachial arc are especially deeply incised, recalling the structure of *Astropecten*.

The adambulacral plates are long and narrow, with the furrow margin slightly convex. Their armature consists of:—(1.) A furrow series of eight moderately elongate, cylindrical, and faintly subclavate spinelets—the length diminishing slightly towards each extremity of the series, but the most aboral spinelet being usually very small. They radiate so very little apart, that their position might almost be described as parallel to one another. (2.) On the actinal surface of the plate immediately behind the furrow series is a parallel row of five or six short papilliform spinelets, less than half the length of the furrow series, even where longest on the inner part of the ray, whilst on the outer part of the ray they are dwarfed into little more than granules. External to this are two lineal series of granules filling the rest of the surface of the plate. In these, however, there is sometimes a little irregularity, which is apt to give a more or less grouped appearance; and two or three additional granules may occur, especially on the inner part of the ray. The eight or ten outermost adambulacral plates at the extremity of the ray have a single comparatively robust conical spine, immediately behind the furrow series, much larger than the other spinelets on the plate. Although these are not noticed without a magnifying glass they are remarkable, as no trace of them is to be found on the other adambulacral plates throughout the ray.

The mouth-plates are elongate and narrow, the united pair being elliptical in outline, slightly convex actinally, and with the median suture imperfectly closed, especially inwardly, where it is often open and gaping. Nearly half their length is free, protruding over the actinostome. The armature consists of a marginal series of nine or ten mouth-

spines. The spines are short, increasing slightly as they approach the mouth, the outermost being much smaller than any of the others. They are slightly subclavate and slightly curved, and radiating apart form an elegant armature. The actinal surface of the plate is covered with numerous short, obtuse, papilliform spinelets, which increase in length and robustness as they proceed towards the inner end of the mouth-plates, those next the marginal series being nearly equal to them in length and very much more robust.

The actinal interradial areas are large and well-developed, and occupied by plates arranged in regular series or columns passing from the adambulacral plates to the marginal plates. Five or six plates may be counted in the series on each side of the median interradial line, and each of the plates in the column imbricates slightly on the next outward plate. Naturally the number of plates in a column decreases as the columns proceed along the ray, and no intermediate plates extend beyond the ninth or tenth adambulacral plate. The intermediate plates adjacent to the adambulacral plates are equal in breadth to the length of the adambulacral plates, and the succeeding plates in a column diminish slightly as they proceed outward. The surface of the intermediate plates is covered with short, uniform, papilliform granules, which form regular rectangular groups, each group being marked out by distinct and well-defined suture-lines or channels from those adjacent, the regularity of the arrangement of the plates being very conspicuous.

The anal aperture is subcentral, but often inconspicuous, as there is nothing in the character of the paxillæ in its neighbourhood to indicate its presence.

The madreporiform body is obscure and hidden by paxillæ, a group of two or three in that position being rather larger than any of the others on the abactinal surface. The position is about one-third of the distance from the margin to the centre.

The ambulacral tube-feet are large and conical, with a small mamelon-like subconical termination.

Colour in alcohol, a greyish white, with a slightly darker or ashy shade over the paxillar area.

Locality.—Station 73. West of Fayal, Azores. June 30, 1873. Lat. 38° 30′ 0″ N., long. 31° 14′ 0″ W. Depth 1000 fathoms. Pteropod ooze. Bottom temperature 39°·4 Fahr. ; surface temperature 69°·0 Fahr.

Remarks.—*Plutonaster notatus* is most nearly allied to *Plutonaster abbreviatus*, but is distinguished by the broad disk and very narrow rays. These characters also serve to separate it at a glance from the other species; and it is further distinguished by the absence of any spines either on the superior or inferior series of marginal plates. In the largest example in the collection, however, minute or rudimentary representatives of infero-marginal spinelets are present on the plates in the interbrachial arc.

6. *Plutonaster abbreviatus*, n. sp.

Rays five. R = 20 mm. ; $r = 7{\cdot}5$ mm. $R > 2{\cdot}5\, r$. Breadth of a ray between the third and fourth supero-marginal plates, 5 mm.

Rays short, tapering slightly along the ray, but rapidly at the extremity, and although narrow they have a comparatively robust appearance. Interbrachial arcs widely rounded. Disk large. Abactinal surface slightly inflated. Actinal surface subplane or slightly prominent centrally, and sloping thence to the margin.

The paxillæ of the abactinal surface are small, compact, and, though very near together, are distinctly spaced; the larger ones are composed of ten to fifteen small, low, rounded, papilliform granules, forming a compact group of uniform height, but sometimes those in the centre are a little more robust than the others. Smaller paxillæ are interspersed, but no order of arrangement is to be observed except near the margin of the disk and the base of the rays, where the paxillæ are disposed in lineal series, the lines of which, if produced beyond the margin, would converge to a point in the prolongation of the median interradial line.

The supero-marginal plates, sixteen or seventeen in number from the median interradial line to the extremity, are small, and form a conspicuous and well-defined border to the disk and rays. When viewed from above their breadth on the abactinal surface is slightly greater than their length; when viewed laterally the length is slightly greater than the height on the outer part of the ray, but the height increases towards the interbrachial arc, and in the innermost plates the height is greater than the length. The supero-marginal plates bear no spines, but their surface is covered with low, rounded, subpapilliform granules, which are well spaced, and those in the median region of the plate are slightly larger.

The infero-marginal plates correspond exactly to the superior series. Their surface is covered with well-spaced, conical, subpapilliform granules. The plates in the interbrachial arc and at the base of the ray bear at the junction of the actinal and lateral regions a single, large, very robust, but conical granule or papilla, which can in no way be spoken of as a spine, though it is the only representative they possess of a lateral spine.

The adambulacral plates are elongate, and have the margin towards the furrow slightly curved. Their armature consists of:—(1.) A furrow series of seven very short, cylindrical, obtuse spinelets, which are almost subequal, except at each extremity of the series, where the spinelets are usually much smaller. (2.) The actinal surface of the plate is covered with equal-sized, uniform, obtuse, papilliform granules, which, though not forming altogether regular lines, have a longitudinal disposition suggestive of two or even three irregular series. There is no trace, even at the extremity, of the single, large, conical spine, which is usually present there in this genus.

The mouth-plates are elongate and narrow. The united pair are prominently convex along the line of suture. Their armature consists of a marginal series of about ten short spinelets, the outer five or six being little more than papilliform granules; the rest are short, conically-pointed spinelets, increasing slightly in length as they proceed inwards. The actinal surface of the plates bears numerous small, obtuse, papilliform granules,

which increase in length and robustness as they approach the inner end of the mouth-plates.

The actinal interradial areas are large and well defined, and occupied by plates arranged in regular series or columns passing from the adambulacral plates to the marginal plates; four or five plates may be counted in the series on each side of the median interradial line, and intermediate plates extend as far as the fourth or fifth infero-marginal plate and the eighth adambulacral plate. The surface of the intermediate or ventral plates is covered with small, uniform, papilliform granules, forming more or less well-defined rectangular groups.

The madreporiform body is obscure and hidden by paxillæ. It is near, but not adjacent to, the marginal plates.

The tube-feet are conical, and have a very small but distinct terminal mamelon-like knob.

Colour in alcohol, an ashy white, with a slight ochraceous shade on the paxillar area.

Locality.—Station 78. Between San Miguel and St. Maria, Azores. July 10, 1873. Lat. 37° 26′ 0″ N., long. 25° 13′ 0″ W. Depth 1000 fathoms. Volcanic mud. Surface temperature 71°·0 Fahr.

Remarks.—This species is most nearly related to *Plutonaster notatus*, but is distinguished by the shorter, broader, and more robust rays. The marginal plates have also a more massive appearance. The differences in point of structure are slight but noteworthy, and the two forms are unquestionably closely allied.

Subgenus *Tethyaster*, nov.

The species placed in this subgenus differ from the other species of *Plutonaster* chiefly in the character of the armature of the adambulacral plates. The whole armature of the plate is spiniform, and is arranged in a co-ordinated group, the general plan of the arrangement having a more or less striking resemblance to that found in *Astropecten*. The adambulacral plates are much broader than in the true *Plutonaster*, and the madreporiform body is simple and exposed.

This subgenus has been established for the reception of the two comparatively little known but well marked species originally described under the names of *Asterias subinermis*, Philippi, and *Astropecten parelii*, Düben and Koren. The former of these was ranked by Müller and Troschel as an *Astropecten*, and subsequent writers followed this reference until Perrier has recently placed the form in the genus *Archaster*. The second species was referred to the genus *Archaster* by Sars, and that determination has been maintained by succeeding writers.

These two species are in my opinion very closely allied to the true *Plutonaster* species; but as they exhibit the above-mentioned constant differences in their morphological

structure, I have considered it desirable to place them apart; the value of the characters, in the present state of our knowledge of the *Plutonaster* group of species, appearing to justify their being ranked as a subgenus.

1. *Tethyaster subinermis*, Philippi, sp.

Asterias subinermis, Philippi, Archiv f. Naturgesch. Jahrg. iii. Bd. i. 1837, p. 193.
Astropecten subinermis, Müller and Troschel, System der Asteriden, 1842, p. 74.
Archaster subinermis, Perrier, Nouv. Archives Mus. Hist. Nat., 2e Sér. 1878, t. i., pp. 33, 57, 88.

Localities.—The Mediterranean area. (Algiers, Naples, Nice, Messina, Sicily.)

2. *Tethyaster parelii*, Düben and Koren, sp.

Astropecten Parelii, Düben and Koren, K. Svensk. Vet.-Akad. Handl., År 1844 (Stockholm, 1846), p. 247, tab. vii. figs. 14–16.
Archaster Parelii, Sars, Oversigt af Norges Echinodermer, Christiania, 1861, p. 35, tab. 3, figs. 1 and 2.

Localities—"Porcupine" Expedition:

Station 31. Between the north of Ireland and Rockall. Lat. 56° 15′ N., long. 11° 25′ W. Depth 1360 fathoms. Bottom temperature 2°·9 C.; surface temperature 13°·8 C.

In Sir Wyville Thomson's popularly written Depths of the Sea, the occurrence of this species is specially mentioned on at least two other occasions (*loc. cit.*, pp. 122, 181), but the exact localities are not given, and I have not seen any other specimens in the collections placed in my hands excepting the one under notice.

Other localities.—Finmark, Lofoten, Coast of Norway, off Shetland.

Genus *Lonchotaster*, Sladen.

Lonchotaster, Sladen in Narr. Chall. Exp., 1885, vol. i. p. 609.

Disk rather large. Rays moderately elongate and comparatively narrow, tapering to a finely pointed extremity. Interbrachial arcs wide and openly rounded.

Marginal plates small, short, and numerous, more or less confined to the lateral wall of the ray. Supero-marginal plates smaller than those of the inferior series. Infero-marginal plates short and broad. The plates of both series covered with low granule-like papillæ, often somewhat squamiform, invested more or less with membrane (succulate). No prominent spines on either series. Large incipient pedicellarian apparatus on most of the infero-marginal plates, and on some of the plates of the superior series.

Abactinal area with numerous small closely-packed paxillæ, composed of small, erect, skin-covered papillæ, and often bearing a pedicellarian apparatus. Abactinal plating circular. The paxillæ present no definite order of arrangement. Papulæ regularly distributed.

Actinal interradial areas small, with intermediate plates arranged in regular columns, and bearing short skin-covered papillæ, three or four larger than the rest in the midst, forming a massive pedicellarian apparatus.

Adambulacral plates large, and longer than broad. Adambulacral armature consisting of short skin-covered spinelets, arranged in several longitudinal series, and one large pedicellaria formed of three or four modified papillæ.

Madreporiform body large and compound.

Anal aperture subcentral and distinct.

There are no superambulacral plates, but a ridge on the ambulacral plate suggests forcibly the appearance of a coalesced or incipient rudiment of that structure.

Remarks.—This is a well-marked and readily distinguishable genus. Although an unmistakable Archasterid, it may be said to hold a more or less intermediate position between *Dytaster* and *Leptoptychaster*—a genus which I have for the present at least felt warranted in ranking amongst the Astropectinidæ. Its nearest affinities are with *Dytaster*, but it is distinguished by the short, cylindrical, pointed rays, by the disproportionately small supero-marginal plates, as well as by a number of minor characters, which, being noted in the diagnosis above given, it is unnecessary to recapitulate. On the other hand, *Lonchotaster* approaches *Leptoptychaster* by the short marginal plates and the small superior series, but is widely separated from that form by the presence of the numerous pedicellariæ; by the compound madreporiform body; by the long, large, adambulacral plates, with their longitudinally disposed armature; and by the peculiar sacculate spinulation. *Lonchotaster* is further characterised by the absence of superambulacral plates, and by the unmistakable presence of an anal aperture.

Chorology of the Genus Lonchotaster.

α. Geographical distribution:—

Atlantic: One species between the parallels of 20° and 30° N.

Lonchotaster tartareus off the West Coast of Africa, between the Canaries and the Cape Verde Islands.

Southern Ocean: One species between the parallels of 60° and 70° S.

Lonchotaster forcipifer in the neighbourhood of the pack ice of the Antarctic Circle, near the meridian of 95° E. longitude. It is also found South of Australia, near the meridian of 110° E. longitude.

β. Bathymetrical range: 1950 fathoms to 2400 fathoms.

Both species are confined to the Abyssal zone.

γ. Nature of the Sea-bottom: Lonchotaster tartareus is found on Globigerina ooze, and *Lonchotaster forcipifer* on Diatom ooze.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Lonchotaster forcipifer . .	Southern Ocean.	1950 to 1975	Diatom ooze.
Lonchotaster tartareus . .	Atlantic.	2400	Globigerina ooze.

1. *Lonchotaster tartareus*, n. sp. (Pl. XVI. figs. 1–5).

Rays five. In the largest specimen R = 88 + mm., r = 20·5 mm. Breadth of the ray at the sixth supero-marginal plate, 16 mm. (The tip is wanting in all the rays of this example.) In a smaller but perfect example R = 55 mm., r = 14 mm. Breadth of the ray at the sixth supero-marginal plate, 9·5 mm.

Rays moderately elongate and comparatively narrow, tapering gradually to a pointed extremity, the outer part of the ray being attenuate and subcylindrical. Interbrachial arcs wide, open, and well rounded. Abactinal area convex and more or less inflated. Actinal area plane. Lateral walls low, very slightly rounded. In all the specimens collected the rays are sharply turned back over the disk, nearly from their base.

The abactinal area of the disk and rays is covered with numerous small and closely packed paxillæ; these are composed of ten to fifteen small, erect, cylindrical, obtusely rounded, skin-covered papillæ, three to five being central. In a very large number of the paxillæ two to four of the central papillæ are enlarged and form a pedicellarian apparatus. In consequence of their skin investiture and erect position the separate papillæ are not noticeable to the naked eye, only the paxillæ as a whole being distinguished; the paxillar area in consequence has a smooth and highly compact appearance. The paxillæ present no definite order of arrangement.

The marginal plates are small and confined entirely to the lateral wall of the ray. The supero-marginal plates are forty-five in number counting from the median interradial line of the longest remaining ray, from which, however, the tip has been broken in the large specimen, with an estimated loss of twenty to thirty plates. Fifty-three are present from the median interradial line to the extremity in a smaller example in which R = 55 mm. The plates are rectangular, with the height rather greater than the length on the inner part of the ray, but subequal on the outer part; and only the upper edge of the plate is visible on the abactinal surface. The plates are covered with low granule-like papillæ, often somewhat squamiform, but longer, more delicate, and cilia-like along the lateral sutures. The supero-marginal plates are devoid of any true spines, but within the interbrachial arc and at the base of the rays in the large example, a small conical tubercle is present close to the upper end of the plate, but it is not found in the smaller specimens. On some of the plates three or four of the papillæ are slightly enlarged and form an incipient pedicellarian

apparatus, the position of which is usually near the aboral margin and not far from the junction of the supero-marginal and infero-marginal series.

The infero-marginal plates correspond exactly in length to the superior series, but their height is distinctly greater, appearing near the middle of the ray nearly twice as great as that of the superior series. Within the interbrachial arc they form a broad border to the actinal area of the disk, but this extent on the actinal area speedily diminishes along the ray, where they are confined essentially to the lateral wall, and their curvature only conforms to the rotundity of the ray. Their surface is covered with papillæ similar to those on the superior series. At the upper margin of normally every infero-marginal plate, and close to the junction with the superior series, is a conspicuous pedicellaria, formed of three or four enlarged and modified papillæ; the apparatus being larger and more fully developed than those on the supero-marginal plates above noticed; sometimes two are present on one plate. In the interbrachial arc about a dozen plates may bear a single small, flattened, tapering, pointed spinelet immediately behind the pedicellaria, but so small that it is little more than an enlarged squamule.

The adambulacral plates are large and massive, rather longer than broad, and with a slightly convex margin towards the furrow. Their armature consists of a furrow series of nine or ten rather short, robust, subprismatic, skin-covered spinelets, equal in length, excepting the outermost at each extremity, and standing parallel to one another and erect, forming a nearly straight series. Each successive series is well-defined. On the actinal surface of the plate, behind the furrow series, is a longitudinal series of about seven shorter spinelets, well-spaced, covered with membrane, which gives them a more or less strongly fusiform appearance; and behind these again two or even three series of small papilliform, skin-covered spinelets, in which the longitudinal arrangement is often more or less disturbed and irregular in consequence of additional papillæ; the outer part of the plate being well filled. At the aboral end of the line of the second series of spinelets on the actinal surface is one large pedicellaria, formed of three or four large modified papillæ; this apparatus is present on every plate, and forms a conspicuous object.

The mouth-plates are large, elongate, prominent, and convex actinally. The outline of the united pair somewhat resembles that of a classical spear-head, in consequence of an angle at the junction of the free margin with the margin adjacent to the first true adambulacral plate. Their armature consists of a marginal series of twelve to fifteen short, erect, skin-covered spinelets on each plate, similar to, but smaller than, those on the adambulacral plates, which are nearly subequal in length, or increase very slightly as they proceed inwards. The actinal surface of the plates is covered with numerous small, low, skin-covered papillæ, which increase in size on the inner part of the plates, but become quite small and granuliform on the outer part, especially towards the margin opposite to the median suture. Though numerous these papillæ are distinctly spaced, but no order of arrangement is distinguishable.

The actinal interradial areas are small, and confined to the interbrachial region, not appearing to extend beyond the fifth or sixth infero-marginal plate counting from the median interradial line; they are occupied by small intermediate plates arranged in regular columns, which bear a number of small, short, skin-covered papillæ, with three or four much larger than the rest in the midst, forming a massive pedicellarian apparatus; a few of the innermost plates in the large specimen have one papilla more spiniform than the others, and this may either be present along with the pedicellaria or in its place.

The anal aperture is subcentral and distinct, although there is no change in the form of the paxillæ in its neighbourhood.

The madreporiform body is compound, and occupies a large circular area about 10 mm. in diameter, its outer edge being not more than 2 or 3 mm. distant from the marginal plates. Numerous large paxillæ, much greater than any of the others on the abactinal area, spring from, or at the junction of, the madreporic plates, almost entirely hiding the striated surface from superficial view. This may be seen in places, however, for the paxillæ are not very closely placed, and here and there one is wanting. The striations are seen to be very fine, numerous, and very slightly convoluted. The papillæ which compose these paxillæ are rather more robust and distinct than those of the general paxillæ, having more the appearance of hemispherical granules when seen from above; and none are modified into pedicellariæ.

Colour in alcohol, a bleached yellowish white. On one of the small specimens there are traces of a dark purple colour along one of the rays, but whether this is the original colour of the species, or is only pigment derived by abrasion from some other organism, I am unable to say.

Locality.—Station 89. Between the Canaries and the Cape Verde Islands. July 23, 1873. Lat. 22° 18′ 0″ N., long. 22° 2′ 0″ W. Depth 2400 fathoms. Globigerina ooze. Bottom temperature 36°·6 Fahr.; surface temperature 73°·5.

2. *Lonchotaster forcipifer*, n. sp. (Pl. XXXI. figs. 5 and 6; Pl. XXXII. figs. 9 and 10).

Rays five. R = 20 mm.; $r = 7$ mm. $R > 3r$. Breadth of a ray between the sixth and seventh infero-marginal plates, 5 mm.

Disk comparatively large and inflated. Rays moderately elongate, subdepressed and subcarinate, narrow and tapering throughout to the extremity. Interbrachial arcs wide and well rounded. Abactinal surface convex over the disk, the slight carination of the rays culminating in a distinct tumidity on the inflated disk-area at a little distance from the base of the ray. Actinal surface of the disk plane, but becoming rounded on the outer part of the ray. Lateral walls low and more or less rounded.

The abactinal surface of the disk and rays is covered with very small and closely packed paxillæ, consisting of five to eight small, short, but comparatively robust, papilliform spinelets, one of which is frequently central. The tips of these papillæ are

thick and obtusely rounded, and they are usually grouped close together in consequence of the crowding of the paxillæ. A number of the paxillæ have two or four enlarged papillæ, which form incipient pedicellariæ. The paxillæ present no definite order of arrangement.

The marginal plates are small and short; the plates of the superior series are the smallest, and are inconspicuous, being much less in height than those of the companion inferior series. The supero-marginal plates are thirty in number counting from the median interradial line to the extremity, and are rectangular with the height about equal to the length throughout. They are covered with short, uniform, equal, papilliform spinelets, similar to, but slightly longer than, those on the paxillæ, and are devoid of any large or true spines whatever. The position of the supero-marginal plates is entirely marginal.

The infero-marginal plates correspond exactly in length to the superior series, but their height or transverse dimension is much greater, being from twice to three times as great in the interbrachial arc, but diminishing along the ray until at the extremity the height and length are subequal. Their posture is such as to form a broad marginal border to the actinal area of the disk and along the inner half of the ray, the breadth diminishing towards the extremity, where they conform to the rounding of the ray, and only a small part is visible in the actinal view. Their surface is covered with short, robust, papilliform spinelets, subconically pointed. The transverse furrows between adjacent plates are well defined. Normally every plate in the interbrachial arc, and as far as midway along the ray, bears at its end, adjacent to the supero-marginal plate, a pedicellarian apparatus, formed by two to four thickened and enlarged papilliform spinelets, and larger than those constituting the general covering of the plate. This pedicellarian apparatus is consequently a conspicuous object, and there are no larger spines on the plate.

The adambulacral plates are longer than broad (in fact remarkably large for so small a form), and they have a slightly convex margin towards the furrow. Their armature consists of a furrow series of seven or eight short, subclavate, papilliform spinelets, subequal in length on the outer half of the ray, but with the median ones slightly longer on the inner part of the ray; these are directed over the furrow, radiating slightly apart. External to the furrow series, and on the actinal surface of the plate, is a longitudinal series of five or six short, equal, papilliform granules (scarcely worthy of being called spinelets); and again external to this are one or two subparallel, but often irregular, longitudinal series of similar and equal-sized papilliform granules or spinelets, the number in these outer series being smaller in consequence of the presence of a large pedicellarian apparatus composed of three or four (usually four) considerably enlarged papilliform spinelets, placed near the aboral margin of the plate, and preventing the extension of the one or two outer series of papilliform granules there.

The mouth-plates are large, elongately oval, and slightly convex actinally. Their armature consists of a marginal series of small spinelets, similar and equal in size to the adambulacral armature on the outer part, but longer, thicker, and conically-pointed at the inner extremity. On the actinal surface of the plate are two or three series of short, well spaced, papilliform granules, one of which is more or less definitely parallel to the median suture line, but the others show no definitely regular order. A few near the inner extremity of the plate are slightly larger than the others, and there is a general diminution in size towards the outer extremity of the mouth-plates.

The actinal interradial areas are comparatively large, and form a triangular area extending as far as the fifth free adambulacral plate, and the sixth or seventh infero-marginal plate. They are occupied by small intermediate plates, which do not appear to present a specially definite order of arrangement so far as can be judged from the small groups of granuliform papillæ or spinelets borne upon them, and these are well spaced. The majority of the plates bear a large pedicellarian apparatus composed of three or four enlarged papillæ, which are very conspicuous in comparison with the small subequal granuliform papillæ on the other plates.

An anal aperture appears to be present in a subcentral position, but there is no modification of the paxillæ in its neighbourhood.

The madreporiform body, which is rather large and partially hidden by paxillæ, is situated near the margin and less than its own diameter distant from the supero-marginal plates. In the narrow intervening space most of the paxillæ form incipient pedicellariæ, and are arranged in well spaced lineal series running from the madreporiform body to the margin, and consequently parallel to the median interradial line.

Colour in alcohol, a slightly brownish white, with a bluish grey tinge over the disk, the latter probably owing to the thinness of the integument and the dark contents of the viscera.

Localities.—Station 156. In the neighbourhood of the pack ice, near the Antarctic Circle. February 26, 1874. Lat. 62° 26′ 0″ S., long. 95° 44′ 0″ E. Depth 1975 fathoms. Diatom ooze. Surface temperature 33°·0 Fahr.

Station 157. South of Australia. March 3, 1874. Lat. 53° 55′ 0″ S., long. 108° 35′ 0″ E. Depth 1950 fathoms. Diatom ooze. Bottom temperature 32°·1 Fahr.; surface temperature 37°·2 Fahr.

Remarks.—This species is clearly very nearly related to *Lonchotaster tartareus*, from the deep water off the west coast of Africa. The example from Station 156, which has served as the type above described, appears to have been probably a young, or at any rate not a fully grown, specimen. After the foregoing description had been written, and the accompanying figures drawn on stone, I received two small specimens, which had been found amongst other material, from Station 157. They are slightly larger than the more southern example, but I place them with little hesitation in the same species. It is

interesting to note that these larger specimens present even closer resemblances to *Lonchotaster tartareus*. Notwithstanding this fact, I see no reason, with the material at present available, to alter the opinion that they belong to the same species as the smaller example from Station 156 above described; and I do not feel warranted in merging them (*Lonchotaster forcipifer*) in the same species as *Lonchotaster tartareus*. They are distinguished by their smaller habit, shorter and flatter rays, simpler paxillæ, besides several other smaller points of detail indicated in the foregoing description. They are, however, unquestionably very nearly related, and until a larger number of specimens of *Lonchotaster forcipifer* can be examined, I feel uncertain whether that form is really worthy of specific rank, or should only be placed as a variety of *Lonchotaster tartareus*.

Subfamily PSEUDARCHASTERINÆ, Sladen, 1886.

Genus *Pseudarchaster*, Sladen.

Pseudarchaster, Sladen in Narr. Chall. Exp., 1885, vol. i. p. 617.

Disk rather large, slightly inflated. Rays moderately long and tapering; almost rigid. Interbrachial arcs well rounded.

Marginal plates forming a well-rounded margin. Both series covered with granules, those on the infero-marginal plates with a tendency to become squamiform. No prominent spines on either series.

Abactinal area with uniform substellate plates, having a more or less oblong central prominence whose major axis lies in the axis of the ray, bearing a compact paxilliform spinulation or granulation. A medio-radial line of plates distinguishable; plates arranged in longitudinal series along the ray. Papulæ regularly distributed.

Actinal interradial areas well developed.

Armature of the adambulacral plates palmo-radiate in disposition, the furrow series forming a radiating semicircular fan, whilst those on the actinal surface of the plate are more or less irregularly grouped.

Madreporiform body small, situated midway between the centre and the margin of the disk.

No pedicellariæ are present.

Tube-feet with a well-developed terminal sucker.

Remarks.—*Pseudarchaster* is interesting as a link between the Archasteridæ and Pentagonasteridæ. This and the succeeding genus *Aphroditaster* form a small group apart, which I have placed as a subfamily, the intermediate character of which is unquestionable.

Synopsis of the Species included in the Genus Pseudarchaster *herein described.*

A. With incipient post-adambulacral fascioles . . . . . *discus.*
B. With no trace of incipient post-adambulacral fascioles.
  a. With small distinct isolated spinelets on the infero-marginal plates; and one prominent spinelet on the actinal surface of the adambulacral plates . *tessellatus.*
  b. Without specialised isolated spines . . . . . *intermedius.*

Chorology of the Genus Pseudarchaster.

α. Geographical distribution:—

Atlantic: Two species between the parallels of 50° N. and 40° S.

Pseudarchaster intermedius off the coast of North America, south of Nova Scotia. *Pseudarchaster tessellatus* off the Cape of Good Hope.

Pacific: One species between the parallels of 40° and 50° S.

Pseudarchaster discus in the Messier Channel, between the western coast of South America and Wellington Island.

β. Bathymetrical range: Shallow water to 147 fathoms.

All the known species are thus confined to the littoral zone.

γ. Nature of the Sea-bottom: Pseudarchaster intermedius on gravel and stones. *Pseudarchaster discus* on Blue mud. *Pseudarchaster tessellatus* in shallow water (?) Simon's Bay.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Pseudarchaster discus . .	Pacific.	147	Blue mud.
Pseudarchaster intermedius .	Atlantic.	49	Gravel and Stones.
Pseudarchaster tessellatus . .	Atlantic.	Shallow water (?)	Shallow water (?)

1. *Pseudarchaster discus*, n. sp. (Pl. XIX. figs. 1 and 2; Pl. XLII. figs. 3 and 4).

Rays five. R = 30 mm.; r = 12 mm. R = 2·5 r.

Rays rather short, broad at the base and tapering gradually towards the extremity, breadth midway between the centre of the disk and the extremity, 6·5 mm. Interbrachial arcs wide and well rounded.

The paxillæ of the abactinal area are roundly hexagonal, tabulate, and closely placed, usually with about a dozen short, roundly truncate, polygonal granules, those occupying the central portion of the tabulum being a shade larger than the rest, whilst some of those at the extreme margin are very small. The primary apical plates (basals and first radials) are distinguishable and bear the largest paxillæ on the disk, the other paxillæ diminish slightly in size as they approach the margin and proceed along the ray. The paxillæ are arranged in regular longitudinal lines parallel to a series which occupies the median dorsal line, and which are rather larger than the rest. A considerable number of intermediate plates (paxillæ) are present between the dorso-central plate and the five "basal" plates, the position of these being at about one-third of the distance from the centre to the margin. The madreporiform body is comparatively large, and lies external to, and independent of, the adjacent basal plate, which is little more than half its size.

The marginal plates form a well-rounded lateral wall, the curvature of which is semicircular in section. The supero-marginal plates are twenty-eight to thirty in number from the median interradial line to the extremity. In the interbrachial arc the height of the plates is about twice their length, but on the outer part of the ray the height is relatively less. The breadth of the marginal border, as seen from above, is also somewhat greater in the interbrachial arc than out upon the ray. The supero-marginal plates are covered with a closely packed polygonal granulation. The granules are short and flatly truncate, and are twice as large on the inferior half of the plates as on the superior. No prominent spines are present on the supero-marginal plates.

The infero-marginal plates correspond to the superior series, but extend rather further on the actinal area than the superior plates do on their area. The granulation of the inferior series has a marked tendency to become squamiform, especially on the inferior portion of the plate where it is much smaller. On the portion of the plate adjacent to the superior series are usually one or two granules larger and more prominent than any of the others. In the interbrachial arc three short, tapering, sharply adpressed spines stand at well spaced distances on the median line of the plate; but out upon the ray seldom more than one is present.

The armature of the adambulacral plates consists of a furrow series of rather elongate, delicate spines, six in number, which increase in thickness towards their free extremity, and are roundly truncate. External to these is a longitudinal series of three spines, rather widely spaced, shorter than the furrow spines, but rather more robust and tapering; and these again are followed by two series of four spines, which are shorter and more closely placed, and usually regular within the disk, but subject to some confusion on the outer part of the ray.

The first series of actinal intermediate (ventral) plates adjacent to the adambulacral plates present a remarkable arrangement of granules. These stand in three or four regular lines, transverse to the furrow, the two lateral series on each plate being inclined slightly

towards the corresponding series on the adjacent plate, and thus form a rough kind of fasciole, if such a term were permissible for the short stumpy granules of which they are composed. About four or five granules are present in each series, and one or sometimes two similar and parallel lines of perpendicular and rather more robust granules occupy the median area of each plate.

The remaining portion of the actinal interradial area is covered with short stumpy polygonal papilliform granules, conically pointed at the tip; and here and there one more elongate and spine-like at well spaced distances apart.

The mouth-plates bear two series of spines: one forming a straight line, and proceeding along the side of the suture uniting the two plates, and the other following the opposite outline of the plate and consequently forming a bent series. The six or seven innermost spines, which fall in the furrow margin of the plate, are as long as the adambulacral spines, the foremost spine of all being larger than the rest; the three or four remaining spines of this series which follow the line of the plate adjacent to the neighbouring adambulacral plate are quite small and papilliform. The inner series, which runs parallel to the median suture of the mouth-plates, is composed of about eight or nine spines, the outermost of which are little more than granules, but the size gradually increases until the innermost is about equal in length to the marginal series.

Colour in alcohol, bluish grey over the paxillar area and mottled with the same on the actinal interradial areas and the infero-marginal plates within the interbrachial arcs; the rest of the animal is a dirty ashy white.

Locality.—Station 307. In the Messier Channel, between the western coast of Chili and Wellington Island. January 4, 1876. Lat. 49° 24′ 30″ S., long. 74° 23′ 30″ W. Depth 140 fathoms. Blue mud. Surface temperature 53°·0 Fahr.

Remarks.—This species is readily distinguished from *Pseudarchaster tessellatus* and *Pseudarchaster intermedius* by its shorter rays and larger disk, the latter being also flatter. It is further specialised by the presence of the remarkable post-adambulacral fascioles, which are not present in the other species. *Pseudarchaster discus* resembles *Pseudarchaster tessellatus* in having a well-defined line of sharp spinelets along the median line of the infero-marginal plates, and resembles *Pseudarchaster intermedius* in having no prominent spine in the outer part of the adambulacral armature.

2. *Pseudarchaster tessellatus*, n. sp. (Pl. XVII. figs. 3 and 4; Pl. XVIII. figs. 9 and 10).

Rays five. R = 48 mm.; r = 16 mm.; R = 3 r.

Rays narrow and slightly tapering, rather abruptly pointed at the extremity, breadth midway between the centre of the disk and the extremity, 8 mm. Interbrachial arcs wide and well rounded.

The paxillæ of the abactinal area are regularly hexagonal, tabulate, and closely placed,

each surmounted by seven or eight short truncate polygonal granules, usually surrounding a central one, but the latter is not always present; in addition to these, a few much smaller ones may also be seen here and there on the periphery. The bases of the paxillæ have star-like prolongations, and single papulæ occur in the interspaces. The paxillæ are largest at a short distance from the centre, and decrease in size as they proceed outward. A perfectly regular series, slightly larger than the rest, proceeds along the median abactinal line of the ray, and the other paxillæ form regular longitudinal series parallel thereto, the paxillæ of one series alternating with those adjacent of the next, and thus form a compactly fitting tessellation. The primary embryonic apical plates are discernible. The five basal plates are rather larger than any of the other paxillæ, and the primary radials are next in size; a considerable number of intermediate paxillæ (plates) intervene between these cycles of plates and the dorso-central, which is small and difficult to distinguish. The periproctal aperture is placed on the right posterior of this plate; and the madreporiform body is independent of, and external to, the adjacent basal plate, its position being consequently a little nearer the centre than the margin of the disc.

The marginal plates form a uniformly rounded lateral wall to the disk and rays. The supero-marginal plates are thirty-five in number from the median interradial line to the extremity. Owing to the curvature of their rounding the supero-marginal plates present a well-defined border of uniform width when viewed from above, the apparent breadth being about equal to half the width of the intermediate paxillar area, midway on the ray. The height is greater than the length in the proportion of three to two or even more. In the interbrachial arc a faint tendency towards convexity is discernible along the median line of a plate perpendicular to the axis of the ray. The supero-marginal plates are compactly covered with a rather large hexagonal granulation, low and truncate, with a slightly smaller series round the margin of each plate, but all uniform in height. The supero-marginal plates are devoid of true spines. The odd terminal plate is small and shield-shaped, deeply excavated inferiorly.

The infero-marginal plates correspond in length and curvature to the superior series; their granulation, however, has a decided tendency to assume a squamiform character owing to its somewhat greater length and oblique attachment. Nevertheless the covering of the plates is still essentially granuliform, thick, and apparently of uniform size with the covering of the supero-marginal plates. Each plate usually bears one to three very small compressed, pointed, inconspicuous spinelets, standing in the median line and wide apart, the largest about 1 mm. in length.

The armature of the adambulacral plates consists of a palmo-radiate furrow series of five or six small straight spinelets, which are delicate towards the base and slightly thickened towards the roundly truncate extremity. The outside spines of each series are a little smaller than the middle ones. External to the furrow series may be one or two longitudinal series, each with four short stumpy papilliform spinelets, slightly tapering towards the

extremity, and shorter than those of the furrow series. In the middle of this outer series, or immediately external to it, is a larger spinelet equal in length to the furrow series, but much more robust, conical, and sharply pointed, usually directed outward and obliquely forward; and behind this, two more series of small granuliform spinelets which form a transition to the spinulation of the infero-marginal and actinal intermediate plates. It should be stated that it is not always possible to define the arrangement with as much regularity as here described, at least in the last three longitudinal series, and the armature in consequence often assumes a more or less grouped appearance. The furrow series, the first external longitudinal series, and the prominent conical spine behind always maintain, however, their regularity.

The actinal interradial areas are well-developed, and the intermediate plates are covered with a uniform, papilliform spinulation, which has a tendency to appear squamiform and similar to the covering of the infero-marginal plates. Here and there short, flattened, adpressed, pointed spinelets occur, suggesting the presence of one in the centre of each of the larger plates on the inner part of the area; but the uniformity of the general spinulation prevents any trace of the individual plates being made out.

The mouth-plates are elongate, and their armature is arranged with great regularity. Each plate bears two lineal series of about ten to twelve papilliform spinelets, which increase in length as they approach the mouth. On the outer part of the plate the companion series on each plate are close together and nearly parallel, but on the inner part of the plate the inner six spinelets are a little more widely spaced from the companion series. There are thus four regular series of spinelets on each pair of mouth-plates, and the innermost spine of each series is slightly larger and more robust than any of the others. The inner six pairs of spinelets differ but little in length, and are considerably longer than the outer spinelets, which are all on the surface of the plate.

Colour in alcohol, a dirty bluish grey over the paxillar area, an ashy yellowish grey on the margins and actinal surface.

Locality.—Simon's Bay, Cape of Good Hope. (Exact position and depth not recorded.)

Remarks.—In the example above described the abactinal area is almost flat, excepting the faintest approach to convexity in the radial areas of the disk, and a corresponding slight sulcus or depression along the median interradial line.

In a younger specimen, having a major radius of 32 mm., the abactinal area of the disk is distinctly convex and inflated, a character which is further emphasised by the faint interradial depression; and the convexity extends along the abactinal area of the rays. It is also to be remarked that in the younger example, the prominent conical spine in the adambulacral armature is not yet conspicuously developed.

3. *Pseudarchaster intermedius*, n. sp. (Pl. XIX. figs. 3 and 4; Pl. XLII. figs. 5 and 6).

Rays five. R = 35 mm.; r = 11 mm. R > 3 r.

Rays moderately long, tapering continuously from the base to a finely pointed extremity; breadth midway between the centre of the disk and the extremity, 6·5 mm. Interbrachial arcs well-rounded.

The paxillæ of the abactinal area are rather small, subcircular, and closely placed, surmounted by ten to fifteen short, truncate, polygonal spinelets, two or three central ones usually larger than the rest, but these are irregular in disposition, and smaller ones may appear at the periphery and increase the difficulty of enumerating the spinelets. The paxillæ are disposed in regular longitudinal lines along the ray, a median radial series being clearly distinguishable and slightly larger than the others. The primary embryonic plates are discernible, though not much larger than the neighbouring plates external to them. The paxillæ diminish slightly in size as they approach the margin and proceed along the ray. A considerable number of smaller paxillæ occupy the area within the circle of the primary basal plates, and the dorso-central plate is small and inconspicuous. The madreporiform body is small and sunken, and lies external to its adjacent primary basal plate.

The marginal plates form a well-rounded lateral wall, the curvature of the inferior series being slightly fuller or more tumid than that of the superior series. The supero-marginal plates are thirty-two in number from the median interradial line to the extremity. The height of the plates in proportion to their length is greatest in the interbrachial arc; and the breadth of the marginal border as seen from above is also rather broader in the interbrachial arc. Midway along the ray it is nearly equal to the breadth of the intermediate paxillar area. The supero-marginal plates bear no spines, but are covered with a low, truncate, closely packed polygonal granulation. The granules are largest near the summit of the arc of curvature; and the plates are slightly tumid along their median line, transverse to the axis of the ray. The odd terminal plate is of a rounded shield-shape, and subtubercular in appearance.

The infero-marginal plates correspond to the superior series; their covering, however, is distinctly squamiform, except at the extreme margins, where the granules at the outer end of the plate partake of the character of those of the adjacent supero-marginal plates, whilst those at the inner end form a transition to the granules of the actinal intermediate plates. Some of the squamules on each plate are more elongate and spiniform than the rest, but the definite line of small pointed adpressed spines noticed in *Pseudarchaster tessellatus* and *Pseudarchaster discus* is wanting in the present species.

The armature of the adambulacral plates consists of a furrow series of five spines, their base line forming an acute angle into the furrow. They are moderately long and thickened towards the extremity, which, in the case of the middle spine, is more or less flattened in the direction transverse to the axis of the ray, but in the other spines in the direction of the margin of the plate to which they are attached. External to the furrow

series is a line of three short papilliform spinelets parallel to the furrow, rather wide apart, and of which the two outside spines often appear as if they belonged to the furrow series. Behind these is a second and similar longitudinal series of three spines, the middle one being often longer than the others; and these are followed by three or four smaller papillæ, completing the armature of the plate. The furrow series have a decidedly palmo-radiate appearance, and the spines of the external series have a tendency to incline at a slight angle towards the next adjacent adambulacral plate.

The actinal interradial areas are comparatively small and are ornamented with short papilliform granules, which appear to be arranged rather widely apart round the margins of the plates; sometimes one or more papillæ are present in the middle of this circlet, and occasionally one is slightly larger than the rest. Consequent on this arrangement the individual plates are more or less defined, but are not distinct; the spinulation is by no means crowded.

The pair of mouth-plates form a subelliptical or widely fusiform outline. Each plate bears a straight line of about ten short papilliform spinelets running parallel to the median suture, and a similar number on the opposite margin of the plate which consequently form a curved series; one or two additional spinelets may be present on the intermediate area of the plate. The marginal spines are about equal in length to the adambulacral spines, but are rather more robust.

Colour in alcohol, a yellowish ashy grey.

Locality.—Station 49. Off the coast of the United States, south of Halifax, Nova Scotia. May 20, 1873. Lat. 43° 3′ 0″ N., long. 63° 39′ 0″ W. Depth 85 fathoms. Gravel and stones. Bottom temperature 35°·0 Fahr.; surface temperature 40°·5 Fahr.

Remarks.—This species is allied in many respects to *Pseudarchaster tessellatus*. The rays, however, are more tapering, the abactinal area is less inflated, the paxillæ though smaller are composed of more numerous spinelets, the marginal border formed by the supero-marginal plates is broader, the covering of the infero-marginal plates is more squamiform, and the definite single line of pointed spinelets which occurs in *Pseudarchaster tessellatus* is not present. There is no large prominent spine on the outer part of the adambulacral armature as in the South-African species.

Genus *Aphroditaster*, Sladen.

Aphroditaster, Sladen, in Narr. Chall. Exp., 1885, vol. i. p. 612.

Disk rather small. Rays elongate, tapering. Interbrachial arcs well rounded.

Marginal plates broad, forming a well-rounded margin; intermediate abactinal area narrow and sunken. Supero-marginal plates with rounded granules, infero-marginal plates with small, uniform, conical-pointed, adpressed (squamiform?) spinelets. No prominent spines on either series.

Abactinal area with large oblong hexagonal paxillæ, the major axis in the direction of the axis of the ray. A conspicuous medio-radial series larger than the rest, each of these paxillæ being well spaced from its neighbours in the series. Papulæ regularly distributed. Abactinal plates arranged in lines parallel to the axis of the ray (longo-radial).

Actinal interradial areas small, with plates bearing small, conical-pointed spinelets similar to those on the infero-marginal plates.

Armature of the adambulacral plates in two longitudinal series parallel to the furrow. The post-adambulacral series of intermediate plates with fascioles at the margins obliquely transverse to the axis of the ray.

Madreporiform body small. No pedicellariæ.

Remarks.—This handsome form resembles in many respects the general facies of several of the unarmed Archasteridæ and Astropectinidæ. It is distinguished from the preceding genus by the longitudinal arrangement of the adambulacral armature, and by the presence of the remarkable "fascioles" on the post-adambulacral plates.

Chorology of the Genus Aphroditaster.

α. Geographical distribution:—

ATLANTIC: One species between the parallels of 30° and 40° N.
Aphroditaster gracilis between the islands of San Miguel and Santa Maria (Azores).

β. Bathymetrical range: 1000 fathoms.

γ. Nature of the Sea-bottom: Volcanic mud.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Aphroditaster gracilis . .	Atlantic	1000	Volcanic mud.

1. *Aphroditaster gracilis*, n. sp. (Pl. XVII. figs. 1 and 2; Pl. XVIII. figs. 7 and 8).

Rays five. R = 59–60 mm.; r = 15 mm. R = 4 r approximately.

Rays elongate, tapering gradually from the base to the narrow, pointed extremity, which is slightly turned upward; breadth midway between the centre of the disk and the extremity, 8 mm. Interbrachial arc well rounded.

The paxillæ of the abactinal area are moderately large, tabulate, and regularly hexagonal; those along the ray have their longest diameter in the direction of the axis of the ray, and all are arranged in regular longitudinal series. A series of paxillæ, which are

larger than the rest, occupy the median radial line, and the other paxillæ form series parallel to this and more widely spaced; only the median series extending along the outer fifth of the ray. Throughout the ray, except at the extreme base, the intermediate paxillar area is distinctly narrower than the breadth of the supero-marginal plates. The primary embryonic apical plates are discernible, and are rather larger than the other plates. Several series of rather smaller intermediate paxillæ intervene between the cycle of basal plates and the dorso-central plate, which is rather small and inconspicuous; the periproctal aperture lies external to this. The paxillæ decrease in size as they recede from the neighbourhood of the primary plates and approach the margin and extremity of the rays. The paxillæ consist of fifteen to twenty short, truncate, polygonal granules, rather well spaced, borne on the tabulum, and often with numerous much smaller cilia-like spinelets appearing at the periphery. In the series of paxillæ forming the median radial line, the short sides of the paxillæ which form the adoral and aboral extremities always have a small series of these cilia-like spinelets directed towards the corresponding set of the adjacent plate, guarding like comb-formed pedicellariæ the little spaces between adjacent plates mentioned above. The madreporiform body is small and slightly sunken; it is subtriangular in outline, and lies external to its adjacent basal plate (paxilla), the area of which is somewhat larger. Its position is about midway between the centre of the disk and the inner margin of the supero-marginal plates.

The marginal plates form a uniformly rounded lateral wall to the disk and rays, and present the appearance, when seen from above, of a broad well-defined marginal border, which is especially emphasised in consequence of the whole intermediate paxillar area being sunken below the level of the supero-marginal plates. The central area of the disk is slightly inflated and convex. The supero-marginal plates are thirty-one in number from the median interradial line to the extremity; and are greater both in breadth and height than in length. The actual height of the innermost plates in the interbrachial angle is nearly twice the length, but the measurement along the surface of curvature,—*i.e.*, the dimension at right angles to the line of length is approximately proportional to the length as five to two. The succeeding plates are a little longer than the foregoing, and their height is rather less; but they decrease as they proceed along the ray, and the relative proportions of length, height, and breadth also become less. All the plates are slightly convex along their median line perpendicular to the axis of the ray. The supero-marginal plates bear no spines, but are covered with rather widely spaced, large, semiglobular, semi-transparent granules which diminish in size near the margins of the plate, a subregular lineal series of small granules standing at the lateral margins. The odd terminal plate is small and shield-shaped; and the tip of the ray is slightly curved upward.

The infero-marginal plates are thirty in number, and although they approximately agree in length with the companion plates of the superior series the divisional sutures are not always directly sub-imposed. The infero-marginal plates bear no spines, but are

covered with short, small, conical-tapering, and sharply pointed thornlets, which are rather widely spaced, adpressed, and diminished in size near the margins, the smaller ones being less sharply pointed. At the extreme margin of the plate adjacent to the superomarginal series there are a few of the rounded granules similar to those on the latter, which gradually form a transition to the thornlets above described. At the lateral margins of the plates the thornlets stand in a lineal series which is directed obliquely towards the adjacent plate and forms a sub-fasciolar fringe arching over the slight channel at the suture. On the inner part of the channel six or seven of the thornlets on each of the adjacent plates are modified into short flattened truncate papillæ, those of one plate being directly opposed to the corresponding series on the adjoining plate, and thus form a peculiar and more definitely fasciole-like organ. On the three innermost sutures in the interbrachial arc this structure is not present, but it may be traced along the ray as a definite organ almost to the tip, diminishing of course in size as it proceeds outwards.

The armature of the adambulacral plates consists of a furrow series of eight or nine short, slightly compressed, obtusely rounded papilliform spinelets, equal in length, and with the flattening at right angles to the direction of the ray. The spines appear slightly geniculated and stand upright side by side, and their base line is a flattened curve, the curvature inwards being greatest at the aboral extremity of the series. The two last spinelets at this end of the series stand slightly apart from the rest and from one another, are somewhat smaller and different in character, and the outermost spinelet at the adoral extremity of the series is also a little smaller than those which actually form the general ranks of the series. The comb of furrow-spinelets, even when standing perpendicularly, touches that of the corresponding plate on the opposite side of the furrow, and consequent on the curvature of the line of furrow spines on each adambulacral plate a series of small circular apertures is formed in the median line of the furrow through which the ambulacral tube-feet may be seen, and indeed were it not for these apertures the ambulacral furrow would be entirely enclosed. External to the furrow series is an irregular lineal series of four or five short, conical-tapering, pointed spinelets, running parallel to the furrow; these are rather wide apart and shorter than the furrow series on the inner part of the ray, where they are little more than blunted papillæ, but increase slightly in length as they proceed outwards, and one or two of the middle ones may be twice the length of the others. On the plates near the mouth there are seldom any other granules external to the lineal series; near the commencement of the free part of the ray, however, a few very small thornlike granules are present, whilst near the middle of the ray these may form a second irregular lineal series external and parallel to the outer series of spinelets above-mentioned.

The actinal interradial areas are comparatively small. The series of plates adjacent to the adambulacral plates have a regular marginal arrangement of papillæ simulating

pseudo-fascioles, obliquely transverse to the furrow. These are formed of six to eight short, flattened, truncate papillæ or spinelets of equal length, placed in lineal series along the adoral and aboral margins of the plate, and directed towards the corresponding series of the adjacent plate; the intermediate area of the plate being occupied by several more or less regularly parallel series of papilliform granules, standing perpendicularly, which are short, subconical, and not flattened. The innermost plates of the series are subtriangular and meet in the median interradial line, their pseudo-fasciole running in continuation of the suture of the mouth-plates. Some of the pseudo-fascioles do not correspond to the junctions of the adambulacral plates. The remaining actinal intermediate plates are comparatively small, and decrease in size as they approach the margin; they are somewhat indistinctly marked off into columns by the suture lines. The plates bear rather widely spaced, short, cylindro-conical, papilliform granules or thornlets, similar to those on the infero-marginal plates but not flattened; their posture is, however, slightly inclined to the plate and directed outward. All are fairly uniform in size, though here and there one slightly larger than the rest may be seen with a magnifying glass, but is scarcely noticeable with the naked eye.

The mouth-plates are small and rather inconspicuous. The margin which falls in the ambulacral furrow bears a lineal series of about ten spinelets similar to the furrow series on the adambulacral plates; four or five short cylindrical spinelets are near the margin adjacent to the adambulacral plate and form an angle with the series just mentioned; and a lineal series runs parallel to the margin which unites with the companion mouth-plate. Sometimes one or two additional spines may be present on the outer part of the plates and some irregularity may occur in the disposal of the spines there, which causes the spinulation of that part of the plate to assume a rather grouped appearance.

Colour in alcohol, ashy white on the marginal plates, with the paxillar area of a darker dirty grey; under side rather more yellow in tint.

Locality.—Station 78. Between the islands of San Miguel and Santa Maria (Azores). July 10, 1873. Lat. 37° 26′ 0″ N., long. 25° 13′ 0″ W. Depth 1000 fathoms. Volcanic mud. Surface temperature 71°·0 Fahr.

Subfamily Archasterinæ, Sladen, 1886.

Genus *Archaster*, Müller and Troschel (1840), *emend.* Sladen, 1886.

Archaster, Müller and Troschel, Monatsber. d. k. Akad. d. Wiss. Berlin, 1840, p. 104; System der Asteriden, 1842, p. 65.

Disk small. Rays elongate, broad, tapering more or less abruptly. Interbrachial angles acute.

Supero-marginal plates confined to the margin, where they form a vertical wall.

Infero-marginal plates extending on the actinal area. Supero-marginal plates crowded with numerous small, uniform, cylindrical, miliary spinelets; no large prominent spines. Infero-marginal plates covered with large, flat, squamiform, adpressed spinelets, with one or more similar, large but short, flattened spinelets at the margin adjacent to the supero-marginal plates.

Abactinal area with subhexagonal oblong imbricating plates, bearing paxilliform groups of short spines. A conspicuous medio-radial series larger than the rest. The other plates form regular obliquely transverse series, each plate imbricating on the next in its own series by a single prolongation of peculiar form developed from the inferior surface of the plate. Papulæ regularly distributed.

Actinal interradial areas almost nil, with very few actinal intermediate plates.

Armature of the adambulacral plates triserial, simulating that of *Astropecten*. A series of three geniculated pointed spines in triangle on the furrow margin; followed by one or two outer series of two to four flattened spines.

Madreporiform body in mid area. Occasional pedicellariæ (subforficiform) are present in the median series of spines on the actinal surface of the adambulacral plates.

Remarks.—The genus *Archaster*, as originally constituted, comprised the two species named by its founders *Archaster typicus* and *Archaster hesperus;* both are very remarkable forms and are widely separated from one another structurally. Indeed it is impossible any longer to retain them in the same genus; and it is difficult to account for their long companionship except on the ground that *Archaster hesperus* is of rare occurrence and has seldom been brought to Europe, and that nearly all the specimens preserved in museums are dry and more or less damaged. The only point then to determine is as to which of the two forms should stand as the type of the genus *Archaster*, which, in other words, would have been so regarded by its founders, and which of the two represents best the characters mentioned in their brief and very general diagnosis of the genus. That *Archaster typicus* fulfils these conditions I think there can be but little doubt; in the first place there is the specific or trivial name; 2d, its priority in the order of description; 3d, its close conformity with the generic diagnosis, which would be very insufficient for a well-preserved example of *Archaster hesperus;* 4th, I am extremely doubtful whether any anus is present in *Archaster hesperus*, and the presence of this aperture was in Müller and Troschel's [opinion] the most marked character of all. On these grounds I consider *Archaster typicus* as the type form of the genus *Archaster;* whilst *Archaster hesperus* constitutes the type of a genus for which I propose the name of *Craspidaster*, the characters of which will be discussed on a subsequent page.

Of all the species which have been referred to the genus *Archaster* since 1840 one only—*Archaster angulatus* of Müller and Troschel—presents the same structural characters as the type; the other forms have now been distributed amongst several different genera.

The following list will serve as a convenient means of reference and may appropriately find a place here :—

Species erroneously referred to the Genus Archaster.	*Now referred to the Genus indicated in the following terms :—*
Archaster agassizii, Verrill	*Plutonaster* (?) *agassizii*, Verrill, sp.
Archaster americanus, Verrill	
Archaster andromeda, (Müller and Troschel, sp.), Lütken	*Psilaster andromeda*, Müller and Troschel, sp.
Archaster arcticus, (Sars, sp.), Perrier	*Leptoptychaster arcticus*, Sars, sp.
Archaster bairdii, Verrill	
Archaster bifrons, Wyville Thomson	*Plutonaster bifrons*, Wyville Thomson, sp.
Archaster christi, (Düben and Koren, sp.), Perrier	*Psilaster andromeda*, Müller and Troschel, sp.
Archaster coronatus, Perrier	*Pontaster coronatus*, Perrier, sp.
Archaster echinulatus, Perrier.	*Pontaster echinulatus*, Perrier, sp.
Archaster efflorescens, Perrier	
Archaster excavatus, Wyville Thomson	*Leptoptychaster kerguelenensis*, Smith.
Archaster floræ, Verrill	*Bathybiaster* (?) or *Psilaster* (?)
Archaster formosus, Verrill	
Archaster grandis, Verrill	*Dytaster* (?) *grandis*, Verrill, sp.
Archaster hesperus, Müller and Troschel	*Craspidaster hesperus*, Müller and Troschel, sp.
Archaster insignis, Perrier	
Archaster lucifer, Valenciennes, M.S., in Perrier	*Dorigona longimana*, Möbius, sp.
Archaster magnificus, Bell	*Moiraster magnificus*, Bell, sp.
Archaster mirabilis, Perrier	*Pontaster mirabilis*, Perrier, sp.
Archaster parelii, (Düben and Koren, sp.), Sars	*Tethyaster parelii*, Düben and Koren, sp.
Archaster pulcher, Perrier	*Pontaster* (?) *pulcher*, Perrier, sp.
Archaster robustus, Verrill	
Archaster sepitus, Verrill	
Archaster simplex, Perrier	*Pararchaster simplex*, Perrier, sp.
Archaster subinermis, (Philippi, sp.), Perrier	*Tethyaster subinermis*, Philippi, sp.
Archaster tenuispinus, (Düben and Koren, sp.), Sars	*Pontaster tenuispinus*, Düben and Koren, sp.
Archaster vexillifer, Wyville Thomson	*Bathybiaster* (?) *vexillifer*, Wyville Thomson, sp.

I have considered it best to withhold any expression of opinion on the generic affinities of some of these forms, as I have not had an opportunity of studying specimens, and I feel unable to form a correct judgment from the descriptions alone. In two or three cases where the description seemed to warrant a surmise I have hazarded a determination, and have placed a (?) after the genus.

Chorology of the Genus Archaster.

a. Geographical distribution :—

Indian and S. Pacific Oceans : Two species between the parallels of 20° N. and 40° S.

Archaster angulatus has its metropolis at Mauritius, and extends to Australia. There is a specimen recorded from Java in the Berlin Museum, named and mentioned by Müller and Troschel,[1] but the

[1] System der Asteriden, p. 66.

determination seems doubtful; it is probably *Archaster typicus*.[1] The species, however, is stated by M. Perrier[2] to occur in the Philippine Islands.

Archaster typicus is found among the islands of the Eastern Archipelago, from the Philippine and Pelew Islands in the north, to New Guinea, the north coast of Australia and New Caledonia; and extends eastward to the Fiji and Tonga Islands. In the west it is found in the neighbourhood of the Nicobar Islands. In the Berlin Museum there are specimens reputed to be from Japan;[3] but I am not aware of authenticated examples from this locality.

β. *Bathymetrical range:* Shallow water to 250 fathoms.

Greatest range of one species: *Archaster typicus*, shallow water to 250 fathoms.

γ. *Nature of the Sea-bottom: Archaster typicus* occurs in shallow water on the coral reefs at the Fiji and Philippine Islands, and on Green mud in 250 fathoms off the Philippine Islands. Information as to the nature of the habitat of *Archaster angulatus* is wanting. All the specimens that I am acquainted with are from shallow water.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Archaster angulatus . . .	Indian Ocean.	Shallow water	... ...
Archaster typicus	S. Pacific.	Shallow water to 250 fathoms.	Coral reefs. Green mud (250 fathoms).

1. *Archaster typicus*, Müller and Troschel.

Archaster typicus, Müller and Troschel, 1840 (April), Monatsber. d. k. Akad. d. Wiss. Berlin, p. 104; System der Asteriden, p. 65.

Astropecten stellaris, Gray, 1840 (November), Ann. and Mag. Nat. Hist., vol. vi. p. 181.

Archaster nicobaricus, Möbius (n. sp., Behn, M.S.), 1859, Neue Seesterne des Hamburger und Kieler Museums, p. 13 (Abhandl. a. d. Gebiete Naturw. hrsg. v. d. naturwiss. Verein, Hamburg, Bd. iv., Abth. 2, 1860).

Localities.—Samboangan, Philippine Islands. Depth 10 fathoms.

On the reefs at Zebu, Philippine Islands.

[1] Dr. v. Martens remarks that this example seems scarcely distinguishable from *Archaster typicus*. (Ueb. ostasiatische Echinodermen, *Archiv f. Naturg.*, Jahrg. xxxii., Bd. i. p. 87.)

[2] *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi. pp. 57, 88.

[3] These specimens are mentioned by von Martens, who also states: 'Mir ist er in Japan nicht vorgekommen," (*Archiv f. Naturg.*, Jahrg. xxxi., Bd. i. p. 353).

Station 200. East of Samboangan, Philippine Islands. October 23, 1874. Lat. 6° 47′ 0″ N., long. 122° 28′ 0″ E. Depth 250 fathoms. Green mud. Surface temperature 85°·5 Fahr.

On the reefs at Kandavu, Fiji Islands. August 1874.

Remarks.—Attention may be drawn to the occurrence of this species at 250 fathoms (Station 200), for it is, so far as I am aware, the greatest depth at which *Archaster typicus* has been found. I can detect no differences worthy of remark between these examples and specimens from shallow water.

It is interesting to note that amongst this series from Station 200 there are two examples which are provided here and there with short, conical, robust, stunted spinelets, standing upright on the upper margin of the supero-marginal plates. These spinelets are quite irregular in their occurrence. In one of the examples less than a dozen are present on the whole starfish, but in the other case they are much more numerous. In this example it is also to be remarked that the lateral walls of the rays are much more vertical than in the other specimens from this locality, the supero-marginal plates being less bevelled or arched towards the abactinal surface, with which the lateral wall consequently forms a more angular junction, resembling in this respect the character of *Archaster angulatus*. In all other respects this interesting specimen is an extremely well-marked example of *Archaster typicus*.

Lütken[1] has placed on record the presence of occasional spinelets on the supero-marginal plates of this species, and it appeared to be of frequent occurrence in the large series of examples from the Nicobar Islands studied by him. Through his kindness I had the opportunity of examining a remarkably fine example from Billeton in the Natural History Museum at Copenhagen, in which from four to six spinelets were present on each side of a ray. In the Museum at Leyden are examples from Java and the Togean Islands (N.E. of Celebes) also similarly characterised, and this form has been named in manuscript by Professor C. K. Hoffmann *Archaster typicus*, var. *multispina*. The presence of these spinelets on the supero-marginal plates is so very irregular and sporadic, and seems to me to be unaccompanied by any other character of sufficient importance, that I fail to appreciate the necessity of ranking the examples in question as a named variety.

The normal composition of the adambulacral armature in this species is:—(1.) A furrow series of three spines, the middle one much in advance of the other two, at the apex of the angular projection of the plate; (2.) on the actinal surface of the plate are three spines, often flattened and truncate, forming a lineal series slightly oblique in relation to the axis of the ray (on the outer part of the ray there are usually only two[2]); behind these are two much smaller spinelets, placed wide apart and close to the margins

[1] *Videnskab. Medd. naturh. Foren. i Kjøbenhavn*, 1864 (1865), p. 136.

[2] Lütken has remarked on the apparent discrepancy in the original diagnosis of Müller and Troschel (System der Asteriden, p. 65), in which two are stated to be the normal number. (*Videnskab. Medd. naturh. Foren. i Kjøbenhavn*, 1864 (1865), p. 135.)

of the plate. Sometimes one of these spinelets might almost be counted as belonging to the oblique series just mentioned, and sometimes one of them is wanting.

The occurrence of the pedicellariæ on the adambulacral plates in this species is very erratic, some examples being well provided, while others have very few. The pedicellariæ, which are large and highly developed, have been figured and described by Perrier.[1] A similar irregularity in the occurrence of the pedicellariæ has been noticed by De Loriol[2] in *Archaster angulatus;* and I have observed the same fact in specimens from Mauritius in my own collection.

Family Porcellanasteridæ, Sladen (1883), *emend.* 1886.

Rays usually narrow in relation to the size of the disk, more or less produced.

Marginal plates in superior and inferior series, thin, lamelliform, apparently naked, or covered only by an extremely thin epidermal tissue.

Abactinal area covered with membrane, beset with simple spiniferous spicules or pseudo-paxillæ, which occupy the whole or only a limited portion of the area. A central epiproctal prominence, more or less defined, frequently developed into an elongate tubular prolongation.

Actinal interradial areas more or less extensive, paved with thin squamiform intermediate or ventral plates, more or less regularly disposed and covered with delicate membrane.

Adambulacral plates elongate, simple, bearing spines (one to five in number) on the furrow margin only; or there may be one or more series of small papilliform granules on the actinal surface of the plate.

Cribriform organs along the vertical sutures of the marginal plates in the interbrachial arcs.

Ambulacral tube-feet in simple pairs, with conical pointed tips.

Madreporiform body usually placed close to the marginal plates.

Remarks.—In this family are included the genera *Porcellanaster*, *Styracaster*, *Hyphalaster*, and *Thoracaster*, which embrace a series of highly remarkable forms, nearly all of them exclusively from great depths, which were first brought to light during the cruise of the Challenger. I now associate with them the genus *Ctenodiscus*, whose structure indicates in many ways a community of descent, and shows a much nearer relationship to the present group than to the Astropectinidæ, with which it has been previously classed. In many respects, however, *Ctenodiscus* differs considerably from the other members of the Porcellanasteridæ; and its position in the family must, for the present, be regarded as

[1] Recherches sur les pédicellaires, &c., p. 95 (separate copy), pl. 2, figs. 12, 13 (*Ann. Sci. Nat.*, 1869, t. xii., p. 287).

[2] *Mém. Soc. phys. et hist. nat. Genève*, 1885, t. xxix., p. 79.

an isolated one. The structural characters of this genus appear to me to warrant its separation in a distinct subfamily.

The Porcellanasteridæ may be said to hold a divergent position between the Archasteridæ and Astropectinidæ, rather than a directly intermediate relation. In some respects they appear to present a more archaic character than the Archasteridæ, but this, it seems to me, is dependent on striking features of structural detail rather than on general facies, and, as a matter of fact, is not borne out by the present state of our knowledge of the older forms of starfish life. Furthermore, this apparently archaic facies is largely due to the remarkable degree in which the Porcellanasteridæ present permanently characters which are regarded, in the majority of forms at least, as essentially embryonic.

The following table will show the distinctive relations of the genera discussed in the succeeding pages, and will serve as a brief epitome of the more prominent superficial characters by which they may be recognised. The genera are divided into two subfamilies.

Synopsis of the Genera included in the Family PORCELLANASTERIDÆ.

A. Cribriform organs highly developed; localised. Actinal interradial areas with no fimbriated transverse channels . . . . . PORCELLANASTERINÆ.

a. Actinal intermediate plates naked. Adambulacral plates with a single series of spines on the furrow margin only. Terminal plates large, armed with conspicuous spines. Cribriform organs one to nine in number.

a. With a tubular epiproctal elongation or anal funnel. Abactinal membrane with simple spiniferous spicules. Actinal intermediate plates not imbricated. Ambulacral furrows wide and exposed. Rays more or less turned back. Cribriform organs one to three, component structure lamelliform . . . . *Porcellanaster.*

b. No tubular epiproctal prolongation, but a more or less definite conical peak may be present. Abactinal membrane with pseudo-paxillæ. Actinal intermediate plates imbricated and arranged in columns. Ambulacral furrows narrow and concealed. Rays not revertible. Cribriform organs five to nine (three in one case only), component structure papilliform.

α. Rays very long. Supero-marginal plates with long robust spines, forming a single series along the median line. Spines of adambulacral armature long and needle-shaped, radiating apart. Marginal plates united along the median line of the rays . . . . . *Styracaster.*

β. Rays short. No spines on the supero-marginal plates. Spines of adambulacral armature short, compressed, forming independent series or fans . . . *Hyphalaster.*

b. Actinal intermediate plates covered with spiniform granules. Adambulacral plates with papilliform spinelets on the outer portion of the plate. Terminal plates very small and inconspicuous; unarmed. Cribriform organs fourteen in number . . . . . *Thoracaster.*

B. With a simplified form of cribriform organ on the margins of each pair of marginal plates. Actinal interradial areas traversed by fimbriated transverse channels, in continuation of the fasciolar or cribriform channels between the marginal plates . . . . . CTENODISCINÆ.

a. A single genus . . . . . *Ctenodiscus.*

Another genus is ranked amongst the Porcellanasteridæ by M. Perrier[1] in a recent notice of the starfishes dredged by the "Talisman" Expedition. To this form the name of *Pseudaster* is assigned, but no description or diagnosis has yet been published, and all that we know about its characters is conveyed in the following brief statement:—"Les *Pseudaster* ressemblent exactement à des *Pentagonaster* à côtés légèrement concaves; leurs organes cribriformes sont rudimentaires, et leur plaque apicale grande et en forme de cœur" (*loc. cit.*, p. 886).

The Cribriform Organs.—A peculiar structure, apparently associated with special functions, occurs in this group. So far as I am aware it is not found, at least in the form presented by the Porcellanasteridæ, in any other starfishes. As the structure is very constant, and appears to furnish a reliable character, useful for classificatory purposes, and also to be one of considerable morphological importance, I have proposed,[2] for the sake of brevity, to speak of it as the "cribriform organ."

The structure in question is situated on the marginal plates in the interbrachial arc; and the number of the supposed organs, which is constant in a species, may vary from one to more than a dozen in each arc. The following brief account will indicate the general character of the organ throughout the series.

In *Porcellanaster* the marginal plates are of uniform thickness and form a level plating, the successive plates fitting close together, and are not separated by any vertical furrow or marginal bevelling of the plate. In a species possessing only one of these organs in each arc (*e.g.*, *Porcellanaster cæruleus*, Pl. XX.), the structure about to be described is located in the median interradial line (fig. 3), and consists of a number of greatly compressed spinelets or lamellæ arranged in vertical parallel lines (fig. 4). Each of the lines thus formed is equal in length to the height of the two series of marginal plates, and is invested with membrane. Ten or more such lines or pseudo-lamellæ are present on each side of the median interradial suture; and these do not stand quite perpendicular to the plane of the marginal plates, but are directed at a slight angle towards the median suture. At the upper or aboral extremity, where the organ terminates on the abactinal area, there is a grouping of the spinelets that belong to the abactinal membrane, which are also rather more robust here than elsewhere on the surface. At the lower extremity of the organ, the outer lamellæ are rather shorter than the inner ones; and each being less than the next inward, a rounded outline is given to the lower or adoral extremity of the organ. Five or six flattened spinelets,

[1] *Comptes rendus*, (November 1885), t. ci. p. 886.

[2] *Journ. Linn. Soc. Lond.* (Zool.), 1883, vol. xvii. p. 215.

directed upward and slightly inward, are placed round this semicircular margin and form an elegant fringe or comb, which closes over, as it were, upon the series of lamellæ.

On examining this organ microscopically, it is found that each line or lamella is made up of a series of small lamellæ, which are placed end to end together, and thus form an apparently continuous line. Each component part or small integral lamella stands upright upon its own rounded scale-like base; and the lamellar plates are made up of a single series of delicate rods united by irregular dissepiments, the whole structure being covered with a membrane, which appears to have been furnished with vibratile cilia. The scale-like plate which forms the basal portion is directly superposed upon the surface of the marginal plate, the parts occupied by the cribriform organ being slightly hollowed out for its reception. The outermost lines (pseudo-lamellæ) are composed of thicker individual lamellæ than any of the others, and these integral lamellæ stand wider apart and resemble flattened spinelets, each built up of several series of rods. On the upper portion of each line transition can be traced from the delicate lamellæ, above described, to the simple rounded cylindrical spinelets of the abactinal membrane.

Judging from the position and character of this organ, as well as from its relation to the abactinal area, it is not improbable that it acts as a percolator; and in such a case it might perhaps be looked upon as the homologue of the armature of minute ciliary spines which borders the vertical furrows that run between the consecutive marginal plates in *Astropecten* and other forms. These fringes of delicate miliary spinelets in *Astropecten* were regarded by Alex. Agassiz[1] as probably the representatives in Asteroids of the specially localised bands of delicate ciliary spinelets known as "fascioles," which are present in many of the genera of irregular Echinoids.

In species which have more than one cribriform organ in each interbrachial arc (Plates XXI., XXII., XXIII., XXIV., XXV., XXVI. and XXIX.), the additional ones occur on the vertical sutures immediately succeeding on each side of the median line, and are identical with the median organ just described. No case of irregularity or intermission occurs in any of the specimens I have examined. The number of cribriform organs present in each arc appears to be always constant in a species; and species exist which possess one, three, five, seven, nine, or even fourteen of the organs respectively. The organ varies in the different species as regards its breadth, the number of vertical parallel lines or pseudo-lamellæ which compose it, and the character of the integral calcareous bodies, of which these latter are formed (Plates XXVII. and XXVIII.) In *Porcellanaster* the component parts are more or less lamellar in form, as described above, whilst in the allied genera *Hyphalaster*, *Styracaster*, *Thoracaster*, the corresponding elements are papilliform (Plates XXVIII. and XXIX.)

The Segmental Pits and Papillæ.—These are peculiar structures situated on the adambulacral plates and the mouth-plates (Plate XXVII. figs. 2, 3, 6, 7). They consist

[1] North American Starfishes, *Mem. Mus. Comp. Zoöl.*, Harvard, 1877, vol. v. No. 1, p. 119.

of a pit which occupies the median area of the adambulacral plate, and is guarded by a small scale-like papilla articulated on the surface of the plate at the side of the pit nearest the furrow. The papilla is capable of being shut down, closing the cavity or pit like a lid; but as to the function of these organs I am quite ignorant. The cavities are filled with a dark-coloured substance which may be either foreign or excreted matter. In one species I believe that the pits are aborted on the outer part of the ray, although the papillæ are present. At present I only know of the existence of segmental pits and papillæ in two species of *Porcellanaster*, both from great depths. There are two pits and their accompanying papillæ on each mouth-plate, and these afford a conspicuous indication that each mouth-plate consists of two adambulacral plates fused together (Pl. XXVII. figs. 2 and 6).

Subfamily Porcellanasterinæ, Sladen, 1883.

Genus *Porcellanaster*, Wyville Thomson.

Porcellanaster, Wyville Thomson, 1877, Voy. of Challenger, Atlantic, vol. i. p. 378.

Rays five, comparatively short, upturned at the extremities, and frequently reverted over the abactinal area. Disk more or less inflated.

Supero-marginal plates not united along the median line of the ray, usually bearing a spine, and these form a series on each side of the ray.

Abactinal area covered with membrane, beset wholly or in limited areas with simple spiniferous spicules. A more or less elongate tubular epiproctal prolongation is present in the centre of the disk, which may be equal in length to the radius of the disk.

Actinal interradial areas paved with thin plates, more or less regularly disposed, but not imbricating and not arranged in definite columns, covered with delicate membrane.

Ambulacral furrows wide and exposed. Armature of the adambulacral plates consisting of one to three elongate, tapering, and sharply pointed spines, usually radiating apart.

Cribriform organs one to three in number.

Segmental pits and papillæ may be present.

Remarks.—Under favourable conditions, I have detected an extremely minute pore at the extremity of the tubular epiproctal prolongation in *Porcellanaster*. It is, however, so very small that I do not think it can act (in the adult at any rate) as an anal aperture, although it may probably be an excretory orifice. (Dr G. O. Sars[1] has

[1] Researches on the Structure and Affinity of the Genus *Brisinga*, University-Program, Christiania, 1875, p. 50.

entertained similar doubts as to the anal function of an excentral aperture on the abactinal area in *Brisinga*. In the case of *Brisinga*, however, the opening seems to me to be really an anal pore.)

I have also found a similar pore at the extremity of the epiproctal peak in *Ctenodiscus*, and likewise in *Hyphalaster*.

Sir Wyville Thomson[1] stated that "the excretory opening [in *Porcellanaster cæruleus*] is very distinct in the centre of the dorsal perisom of the disk." This seems to me rather an inadvertent remark, and probably arose from the examination of a specimen in which the extremity of the epiproctal funnel was either invaginated or actually broken off.

I have observed under the microscope that some of the small membrane-invested spinelets on the abactinal area are either cleft or double, and simulate the appearance of the sacculate pedicellariæ in *Bathybiaster* described by Danielssen and Koren.[2] Whether they actually perform the functions of pedicellariæ or not, I am unable to say. They are generally situated near the marginal plates, and are usually most numerous in the neighbourhood of the madreporiform body.

So far as I can judge from the description, the genus *Caulaster*, founded by Perrier[3] in 1882, seems to be a synonym of *Porcellanaster*. The new genus was established for the reception of two small starfishes dredged by the "Travailleur" in 1880 off the north coast of Spain from a depth of 1960 and 2650 metres respectively, and the name had reference to the "dorsal peduncle" with which they are furnished. Both specimens are very small, the larger of the two measuring only 5 mm. from the centre of the disk to the extremity of a ray. In the smaller one the embryonic plating of the disk is still present. The few striking characters briefly mentioned by M. Perrier accord in every particular with *Porcellanaster;* and so far as I am able to judge from the meagre information, I am constrained to regard these interesting starfishes as young forms of some species of that genus. As to their identity with, or distinction from, the western Atlantic species *Porcellanaster cæruleus*, Wyville Thomson, I am not in a position to express an opinion. The smallest examples of that form with which I am acquainted are larger than those named *Caulaster pedunculatus* by M. Perrier.

In referring to the alliance of his type with *Ctenodiscus*, M. Perrier states that the marginal plates of *Caulaster* form only a single row ("les plaques marginales, peu visibles, ne forment qu'une seule rangée, comme chez les *Ctenodiscus*"). I venture to think that on closer examination a double row (*i.e.*, a supero-marginal

[1] Voyage of the Challenger, The Atlantic, London, 1877, p. 380.

[2] *Nyt Mag. f. Naturvidensk.*, 1877, Bd. xxiii., 3die Hefte, p. 63; Den Norske Nordhavs-Expedition, 1876–78, xi., Zoologi, Asteroidea, Christiania, 1884, p. 90.

[3] *Comptes rendus* (Dec. 1882), t. xcv. p. 1379.

and an infero-marginal series) will be found to exist. There is distinctly a double row in *Ctenodiscus*.

The young form of *Porcellanaster* from Station 137, described on a succeeding page (p. 145), presents in such a remarkable manner all the characters mentioned by Perrier as characterising *Caulaster* (excepting only the single row of marginal plates ascribed to *Caulaster*, in my opinion with doubtful accuracy), that I cannot any longer believe that the two forms belong to different genera. If my assumption is correct *Caulaster* as a generic name must obviously give place to *Porcellanaster*.

If my opinion that *Caulaster* is in reality a young *Porcellanaster* be correct, or if I read the statements concerning that form rightly, the homology which Perrier has sought to establish between, what he calls, the "pédoncule dorsal" of that starfish and the stem of a Crinoid has no morphological basis whatever. The so-called dorsal peduncle seems to me to be nothing more or less than an extraordinarily developed anal funnel (whether aborted in function or not is immaterial for the present argument), and as such it is the homologue of the anal funnel of a Crinoid. According to my views of Echinoderm morphology it could not possibly be the homologue of the stem of a Crinoid, because the dorso-central plate still exists independently in *Porcellanaster*, and clearly also in the so-called *Caulaster*, according to Perrier; and, in my opinion, it is with this plate alone that any relationship with the stem of a Crinoid could exist in the apical system of an Asterid. Furthermore, the "pédoncule dorsal" of *Porcellanaster* and *Caulaster* is excentric in position and situated at the side of the dorso-central plate, as is invariably the case with the periproct in all larval Asterids in which we have been able to observe the primative apical plates. If therefore the assumption that the "pédoncule dorsal" of *Caulaster* is the homologue of the stem of a Crinoid be admitted, it follows logically that the anal aperture or periproct of all Asterids must be regarded as the homologue of the stem in a Crinoid; and it will impose upon those who accept this view the task of indicating a new and rational homology for the dorso-central plate, and also of explaining the extraordinary morphological changes which have led to the terminal extremity of the alimentary canal of the starfish coming to occupy the position of the stem in the Crinoid, an independent structure with which, in that type, it always has been and still remains, unconnected, and from which it is altogether distinct.

MM. Danielssen and Koren[1] have ascribed, but in more guarded terms, a similar homology to the dorsal appendage of *Ilyaster*. They accept Perrier's deductions with reference to *Caulaster*, but they do not discuss the question at issue, neither do they throw any light upon the validity of the argument. They appear, however, to consider that the

[1] *Nyt Mag. f. Naturvidensk.*, 1883, Bd. xxviii. 1, pp. 7–10; Den Norske Nordhavs-Expedition, xi., Zoologi, Asteroidea, Christiania, 1884, pp. 102, 103.

form which they have described so ably under the name of *Ilyaster mirabilis* supports the views upheld by Perrier, and should be ranked in the same category as forming "a connecting link between Crinoidea and Asteroidea" on account of the presence of its remarkably developed dorsal appendage.

It is probable that the apical plates of *Ilyaster* have never yet been observed (they had not been seen when the type, which is probably too large to possess them, was described); and I venture to consider that the abactinal prolongation in *Ilyaster*, like that in *Caulaster*, is also an anal funnel (whether functional or not I cannot say), and that, such being the case, it does not lend any support to the view that this remarkable development is in any way homologous to the stem of a Crinoid. I would further remark that this most interesting form *Ilyaster mirabilis* appears to me to be more nearly allied to the Astropectinidæ than to any of the genera which I have included in the family Porcellanasteridæ.

With reference to the foregoing remarks, it may be pointed out that Dr P. Herbert Carpenter[1] hesitates to accept the homology of the dorsal appendage of *Caulaster* and *Ilyaster* with the stem of a Crinoid, and considers that the assumption is not yet satisfactorily proved. Carpenter also points out that Perrier's comparison of the plates round the dorsal appendage of *Caulaster* with those forming the periproct of an Urchin cannot be followed out in detail, as, according to Perrier's description, the apical system of *Caulaster* consists, not of genitals and oculars (basals and radials) as in an Urchin, but of under-basals and basals. With these views I entirely concur.

In conclusion I would add that I am altogether at a loss to reconcile Perrier's view according to which "le dos des Astéries correspondrait à la région buccale des Oursins et non à leur région anale"[2] with his comparison of the apical system of *Caulaster* with that of an Urchin.[3] For either the proposition is self-contradictory, or, if it be true that the abactinal area of *Caulaster* corresponds to the apical region of the Echinoid, whilst the abactinal area of all other Asterids corresponds to the buccal region, it seems to me only another way of saying that the abactinal area of *Caulaster* corresponds not to the abactinal area, but to the actinal area in other Asterids. I will not do M. Perrier the injustice of thinking for a moment that he believes this to be the case.

For my own part I consider, along with Lovén,[4] Carpenter,[5] Agassiz,[6] and other naturalists, that the buccal region of an Asterid, of an Echinoid, and of a Crinoid are correspondent, and consequently that the apical systems of an Asterid or Echinoid and the calyx of a Crinoid are homologous parts.

[1] Report on the Crinoidea, Voyage of H.M.S. Challenger, Zool. Chall. Exp., 1884, Part xxxii. p. 401.
[2] *Nouv. Archives Mus. His. Nat.*, 2e Sér., 1884, t. vi. p. 162.
[3] *Comptes rendus* (Dec. 1882), t. xcv. p. 1380.
[4] Études sur les Échinoïdées, *K. Svensk. Vetensk. Akad. Handl.*, 1874, Bd. xi. No. 7.
[5] Report on the Crinoidea, Voyage of H.M.S. Challenger, Zool. Chall. Exp., 1884, Part xxxii. p. 401.
[6] *Mem. Mus. Comp. Zoöl.*, Harvard, 1877, vol. v. No. 1.

Synopsis of the Species included in the Genus Porcellanaster *herein described.*

A. One cribriform organ in each interbrachial arc. Adambulacral plates with two or three spines. No segmental pits or papillæ.	
a. Rays short. Abactinal membrane with spinelets confined to limited areas .	*cæruleus.*
b. Rays long. Abactinal membrane entirely covered with spinelets.	
a. Rays tapering. Spines on each supero-marginal plate, long and delicate. Terminal plate small, with five spines. Spinelets of disk clavate	*caulifer.*
b. Rays broad and robust. Spines on two plates only, stout. Terminal plate large and tubercular, with three spines. Spinelets of disk cylindrical	*tuberosus.*
B. Three cribriform organs in each interbrachial arc. Adambulacral plates with one spine. Segmental pits and papillæ present.	
a. Rays long and robust. Abactinal membrane entirely covered with spinelets. Spines on each supero-marginal plate, long and thick . . .	*crassus.*
b. Rays short and delicate. Abactinal membrane with spinelets confined to limited areas. No spines on the supero-marginal plates or only rudimentary	*gracilis.*

Porcellanaster eremicus is not included in the foregoing table on account of its very immature condition. To place the characters presented by such an early phase of growth in comparison with those pertaining to the adult stage of the forms above mentioned would clearly be not only useless but misleading.

Two species of *Porcellanaster* are "named" by M. Perrier[1] amongst the material dredged by the "Talisman," but no description has been published. The forms consequently cannot be recognised.

Chorology of the Genus Porcellanaster.

a. Geographical distribution:—

Atlantic: Two species between the parallels of 50° N. and 40° S.

Porcellanaster cæruleus off the eastern coast of the United States of America. *Porcellanaster eremicus* midway between the Cape of Good Hope and the Island of Tristan da Cunha.

Pacific: Three species between the parallels of 40° N. and 40° S.

Porcellanaster tuberosus off the coast of Japan, south of Kawatsu. *Porcellanaster crassus* in the mid south Pacific, near the meridian of 135° W., approximately midway between Sydney and Valparaiso. *Porcellanaster gracilis* off the western coast of South America, between Valparaiso and the Island of Juan Fernandez.

[1] *Comptes rendus*, 1885, t. ci. p. 886.

Eastern Archipelago: One species between the parallels of 0° and 10° S.

Porcellanaster caulifer in the Arafura Sea, between Australia and New Guinea.

β. *Bathymetrical range:* 800 fathoms to 2550 fathoms.

All the species are confined to the Abyssal zone, and one only (*Porcellanaster caulifer*) is found at a less depth than 1000 fathoms. Three species, *Porcellanaster crassus*, *Porcellanaster gracilis*, and *Porcellanaster eremicus* are found in depths greater than 2000 fathoms.

Porcellanaster cæruleus is the only species known to me from more than one locality, and its range is very constant, varying only from 1240 to 1350 fathoms.

γ. *Nature of the Sea-bottom:* Three species are found on the Blue mud, viz.:

Porcellanaster cæruleus in the Atlantic, and *Porcellanaster gracilis* and *Porcellanaster tuberosus* in the Pacific. *Porcellanaster crassus* and *Porcellanaster eremicus* are found on the Red clay in the Pacific and South Atlantic respectively. *Porcellanaster caulifer* lives on Green mud in 800 fathoms.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Porcellanaster cæruleus . .	Atlantic.	1240 to 1350	Blue mud.
Porcellanaster caulifer . .	Eastern Archipelago.	800	Green mud.
Porcellanaster crassus . .	Pacific.	2335	Red clay.
Porcellanaster eremicus . .	Atlantic.	2550	Red clay.
Porcellanaster gracilis . .	Pacific.	2225	Blue mud.
Porcellanaster tuberosus . .	Pacific.	1875	Blue mud.

1. *Porcellanaster cæruleus*, Wyville Thomson (Pl. XX. figs. 1–7).

Porcellanaster ceruleus, Wyville Thomson, 1877, Voy. of Challenger, Atlantic, [vol. i. p. 378, figs. 97 and 98.

Rays five. R = 22 mm.; $r = 10{\cdot}5$ mm. (the largest example). R = 2 r, approximately.

Marginal contour substellate, with moderately developed rays proceeding from a truly pentagonal body-disk, the minor radius being in the proportion of 48–50 per cent. When viewed from above the rays seem comparatively small and have the appearance of springing somewhat rapidly from the angles of the disk, the interbrachial arc being very wide and not unfrequently quite straight, or even curved outward, rather than rounded. Disk more or less gibbous and inflated, the height being sometimes equal to one-third of the greatest diameter, but generally less. The arching or inflation of the

abactinal surface extends along the ray and tapers off with a graceful curve towards the extremity, which causes the rays to have a very short appearance when seen in profile.

The abactinal area is covered with a thick coriaceous integument, the usual meshwork skeleton of calcareous plates being altogether wanting. The membrane is indurated with a number of minute circular spicules, some of which bear a vertical spinelet, resembling the surface spicules of *Thyonidium* and other Holothuroids. These spinelets are sparsely distributed over the central portion of the abactinal area and along bands that run therefrom to the interbrachial arc, in the median interradial line. The spinelets are long and thin, and, being made up of fine calcareous rods united by short transverse dissepiments, present under the microscope a very open structure somewhat resembling the delicate hair-like spines of certain irregular Echinoids. The spinelets are clothed with thick investing membrane, which not unfrequently develops a knob at the extremity, and gives a club-shaped character to the appendage. A more or less prominent tubular epiproctal prolongation is present in the centre of the disk; in some examples measuring between 2 and 3 mm. in length, but shorter in others. It is a subcylindrical tube less than a millimetre in diameter, springing directly from the abactinal area, tapering very slightly towards the extremity, and is indurated with a close plating of very minute spinulate spicules.

The marginal plates form a deep conspicuous band, and stand as a perpendicular wall in the interbrachial arc, bending gently inward above and below. Along the rays the supero-marginal series arch well over on the abactinal surface, and leave only a very constricted space along the median line of the ray between the corresponding plates of each side. The supero-marginal plates, which are six or seven in number exclusive of the terminal, are bounded by straight lines, and vary from a quadrate to a subrhombic form according to position. The height and length are nearly equal, the latter being usually the greatest dimension, although in some specimens the proportions may be reversed. Normally each of the supero-marginal plates bears a short conical spinelet on its upper edge, but not unfrequently these become aborted into little more than tubercles, and are sometimes absent altogether, especially on those plates which are innermost in the interbrachial arc, and sometimes also on the penultimate plate of the ray. The terminal plate is moderately large and prominent, with the abactinal surface slightly tubercular, the adoral margin being deeply indented in the median line, and the lateral angles fully rounded. The whole plate is directed at a slight angle upward in relation to the ray, a circumstance which emphasises the strongly upturned appearance presented by the rays, the general habit of which seems always to be more or less bent upward or backward. Three moderately robust spinelets are borne on the terminal plate—one placed at the summit of the tubercular swelling in the median line of the ray and directed vertically upwards, and two somewhat smaller ones which stand one on each side at the extreme anterior lower angles of the plate and directed outward.

The infero-marginal plates usually correspond both in number and in length to the companion superior series, but sometimes a little irregularity occurs at the extremity of the ray, and an additional plate may be present. The infero-marginal plates are not so high as the superior series, and are longer than high, excepting perhaps one or two of the innermost plates in the interbrachial arc. The actinal edge of the plates is curved outward, which gives a festooned appearance to the lower margin of the series; and after the first two plates in the interbrachial arc the succeeding ones have their proximal end higher than the distal end, so that the series tapers off gradually towards the extremity of the ray.

One cribriform organ is present in each interbrachial arc. It is situated on the median interradial suture, and is rather broad and well defined. The structure is lamelliform, and has been described above. (See Pl. XX. figs. 3 and 4.)

The ambulacral furrows are wide, open, straight, tapering from the mouth to the extremity, and occupy nearly the whole of the under surface of the ray. The adambulacral plates are rather short and broad, with the adoral and aboral extremities somewhat incurved, leaving a small cavity between adjacent plates, which is filled up with membrane. The armature of each plate consists of two short, sharply-pointed, conical spinelets, the adoral one being the longest. The spinelets are placed slightly oblique, and are covered with an investing membrane which unites them together at the base and joins them up to the neighbouring pairs, concealing to a certain extent their actual size and shape.

The mouth-plates are moderately large and prominent, sharply upturned along the line of junction, forming a swollen semi-tubercular keel considerably elevated above the general surface of the actinal area. A single mouth-spine is borne at the mouth-angle, placed on the line of suture of the united pair and directed upwards; and two smaller, compressed, subtriangular mouth-spines stand on the margin of each mouth-plate near their aboral extremity. No secondary mouth-spines are present on the surface of the mouth-plates.

The actinostome is wide, occupying fully two-fifths of the actinal area of the disk; and the mouth is situated in the centre of a naked leathery membrane and furnished with a well-developed muscular lip.

The actinal interradial areas form a fairly regular equilateral triangle—the distance from the innermost point of the mouth-angle to the place where the area terminates and the marginal plates join up immediately to the adambulacral plates being about half-way out on the ray, and approximately equal to the base of the area that extends along the interbrachial arc. The area is covered with a compact pavement of calcareous plates, subhexagonal or subquadrate in form, arranged in columns parallel to the median interradial line. The whole is covered with a thick membrane, through which the plates are scarcely perceptible until the specimen is dried.

The madreporiform body is large and conspicuous, subcircular or oval in form, and situated in an interradium close up to the supero-marginal plates, and consequently adjacent to the cribriform organ. Sometimes it is subtriangular in contour, with the base directed to the margin, and the striæ form lines sharply bent at an angle, running more or less parallel with the sides of the triangle, the open angle being directed towards the base.

Colour in alcohol, yellowish white, with a bluish-grey shade over the disk. The marginal plates and the actinal interradial areas have a peculiar glazed appearance, consequent on the character of the investing membrane.

Individual Variation.—A very slight amount of difference may be noticed in a series of specimens in the height of the lateral wall of the ray; and in some specimens the marginal plates stand rather more vertical, and are less arched towards the abactinal surface. In some specimens the small conical spinelet or tubercle on the upper margin of the supero-marginal plates is more strongly developed than in others; and in other examples it is absent altogether from some plates here and there, perhaps owing to abrasion. In some examples a very minute thornlet may be seen occasionally on an intermediate plate here and there in the actinal interradial area. In one specimen a third spinelet is present on some of the adambulacral plates, usually about the middle of the ray or near the mouth.

In some examples the rays are rather broader at the base than in others, and this is especially noticeable in a large example from Station 46; in others they are longer and more attenuate throughout.

Locational Variation.—The specimens from Station 45 appear to be of a rather smaller size than those from other Stations; the rays also are narrower, and the small spinelet on the supero-marginal plates is slightly more delicate and spine-like than in specimens of the same size from Station 47.

On the whole, however, I am by no means certain that these slight modifications can be correctly ranked as locational variations in preference to individual variations; a much larger supply of material would be necessary to decide the point than I have had at my disposal.

Young Phase.—The smallest example, unquestionably belonging to this species, that I have seen, measures R = 8 mm.; $r = 4$ mm., approximately; and it already presents the characters of the adult in a remarkable manner. I have no hesitation in referring it to the species. The abactinal membrane is very thin, and the spiniferous spicules are confined to definite areas which traverse the interradial lines. The anal funnel is well developed. There are four supero-marginal and four infero-marginal plates, and traces of a small fifth plate are visible, the infero-marginal one being the most developed, and appears to be the first formed. The cribriform organs are large and conspicuous. The adambulacral plates bear two short conically pointed spinelets. The mouth-plates have

one small conical spinelet at the junction of the pair of plates and two others on the margin of each plate. The odontophore is visible. The actinal interradial areas are covered with a complete pavement of plates.

Localities.—Station 45. Off the coast of North America, east of Delaware and Maryland. May 3, 1873. Lat. 38° 34′ 0″ N., long. 72° 10′ 0″ W. Depth 1240 fathoms. Blue mud. Bottom temperature 37°·2 Fahr.; surface temperature 49°·5 Fahr.

Station 46. Off the coast of North America, east of New Jersey. May 6, 1873. Lat. 40° 17′ 0″ N., long. 66° 48′ 0″ W. Depth 1350 fathoms. Blue mud. Bottom temperature 37°·2 Fahr.; surface temperature 40°·0 Fahr.

Station 47. Off the coast of North America, east of New Jersey and Long Island. May 7, 1873. Lat. 41° 14′ 0″ N., long. 65° 45′ 0″ W. Depth 1340 fathoms. Blue mud. Surface temperature 42°·0 Fahr.

Remarks.—This species is at once distinguished from the other members of the genus by the single cribriform organ in each interbrachial arc, by the absence of segmental pits and papillæ, by the short rays, and by the spinelets on the abactinal membrane being confined to limited areas which occupy the interradial lines and the central region of the disk.

2. *Porcellanaster caulifer*, Sladen (Pl. XXI. figs. 5–10; Pl. XXVII. figs. 9–12).

Porcellanaster caulifer, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 222

Rays five. R = 21 mm.; $r = 6{\cdot}5$ mm. $R < 3\,r$.

Rays moderately long and slender, not much broader at the base than at mid-arm, tapering only slightly, the minor radius in the proportion of 30 per cent. Interbrachial arcs rather flatly rounded. Disk high and much inflated.

The abactinal area is covered with an integument, beset with spinelets, excepting at the very base of the rays. The spinelets are simple, delicate, clavate, or thickened at the extremity, covered with membrane, and rather widely spaced. Large papulæ-like bodies are distributed here and there. A very long tubular epiproctal prolongation or anal funnel rises from the central region of the disk, in length nearly equal to the minor radius, rather narrow and tapering towards the extremity.

The marginal plates are moderately high, and form a perpendicular wall in the interbrachial arc, but arch over on the abactinal surface of the rays, and leave only a narrow space along the median line between the corresponding plates of the two sides. The supero-marginal plates are seven in number, exclusive of the terminal; all are longer than high, and each carries a long, delicate, acicular spinelet. The terminal plate is large and elongate, very slightly prominent abactinally, and flattened; it normally carries three spinelets, though sometimes more are present. These are longer than the spinelets on the other supero-marginal plates, and are delicate and acicular; one

is placed above the termination of the ambulacral furrow in the median line, and one on each side a little beneath. Occasionally one or both of these lateral spines may be accompanied by a supplementary spine, thus producing the additional number.

The infero-marginal plates correspond in number and length to the superior series, and are, like them, longer than high; they do not curve round upon the actinal surface of the ray, which is flat.

One cribriform organ is present in each interbrachial arc; it is very broad, well defined, and with a deep depression down the median line. The structure is lamelliform. (See Pl. XXVII. fig. 12.)

The ambulacral furrows are broad, open, and straight. The adambulacral plates are small, rather elongate in the direction of the ray, and rather widely separate. The margin towards the furrow is incurved, and the adoral extremity is somewhat scooped out, and has the margin slightly lipped, the aboral extremity of the next plate being rounded, thickened, protruded, and lipped in correspondence; but the two do not join up closely, and a narrow vacant space is left between. The armature of the adambulacral plates consists of two minute, delicate, acicular, and sharply-tapering spines; the adoral spine, which is the longest, is placed at the extreme adoral end of the margin of the plate, and the companion spine is situated at the commencement of the curve along the furrow margin; the long spine is consequently directed almost transversely across the furrow, whilst the small spine stands at an angle of about 45° to it.

The mouth-plates are rather broad and suboval, elevated into a moderately high and well-rounded keel, a small elliptical space being left between the two adjoining plates near the middle of the median line. The aboral extremity of the plates is gracefully rounded, and the margins of the plates do not meet along the lower portion, but leave a triangular outline of the odontophore visible. The armature of the mouth-plates consists of one short conical spinelet at the adoral peak of the mouth-angle, standing at the junction of the two plates, and two small spinelets, similar to this, on the lateral margin of each plate. The aboral spinelet is placed near the middle of the margin, and the companion one, which is smaller, nearer the adoral extremity of the plate. All the mouth-spines are smaller than the spines which constitute the armature of the adambulacral plates.

The actinal interradial areas are small, subtriangular, and covered with membrane; the actinal intermediate plates are irregular and small.

Colour in alcohol, greyish white, with a darker shade of bluish grey over the disk.

Locality.—Station 191. In the Arafura Sea, west of the Arrou Islands. September 23, 1874. Lat. 5° 41′ 0″ S., long. 134′ 4′ 30″ E. Depth 800 fathoms. Green mud. Bottom temperature 39°·5 Fahr.; surface temperature 82°·2 Fahr.

Remarks.—*Porcellanaster caulifer* is distinguished by the elongate tapering rays, by the long delicate spinelets on each supero-marginal plate, by the small terminal plate

with five spines, and by the clavate spinelets of the disk. This species is especially remarkable for the length of the tubular epiproctal prolongation or anal funnel.

3. *Porcellanaster tuberosus*, Sladen (Pl. XXIII. figs. 1–4; Pl. XXVII. figs. 13–16).

Porcellanaster tuberosus, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 223.

Rays five. R = 18·5 mm.; r = 6 mm. R = 3 r.

The rays spring gradually from the angles of the disk and taper moderately towards the extremity, maintaining a robust character throughout; the minor radius is in the proportion of 32 per cent. The disk is not high, and very slightly inflated. The interbrachial arcs are well rounded.

The abactinal area is covered with a rather fleshy integument beset with simple spinelets somewhat closely placed; these are short, cylindrical, obtuse, covered with membrane, and occupy the whole of the surface excepting only the extreme angle at the base of the ray. A well-developed epiproctal tubular prolongation rises from the centre of the abactinal area, and is nearly equal in length to the distance between the centre and the inner edge of the marginal plates in the interbrachial arc; it tapers very slightly towards its extremity, and is indurated with spicular spinelets like the rest of the abactinal membrane.

The marginal plates form a deep margin and curve over roundly in the interbrachial arcs, the inferior as well as the superior series being visible from above. Upon the rays the superior series arch well over and almost meet in the median dorsal line, giving to the ray a more or less subcarinate character. The supero-marginal plates are four in number from the median interradial line to the extremity, exclusive of the large terminal plate, and all are distinctly longer than high. The second and third supero-marginal plates from the median interradial line bear short, conical, upright spinelets; but all the rest are unarmed excepting the terminal plate, which carries three spines—one at the extremity in the median line of the ray, and one on each side at the anterior extremity of the inferior margin of the plate. The terminal plate is swollen and prominently tubercular abactinally, and is excavated on its outer extremity for the passage of the terminal ambulacral tube. In one ray of the specimen under notice, the penultimate supero-marginal plates are also swollen and ankylosed in such a manner as to resemble the terminal plate, and bear a single spinelet.

The infero-marginal plates, which are five in number, are much shallower than the superior series, and also shorter. The two series consequently do not correspond, a result probably brought about by the extreme development of the terminal plate, which occupies the space of both superior and inferior plate.

One cribriform organ is present in each interbrachial arc; it is rather broad and has a deep depression down the median line. The structure is lamelliform. (See Pl. XXVII.)

The ambulacral furrows are wide and open, occupying nearly the whole of the actinal surface of the ray. The adambulacral plates are small, and form regular triangular prominences, which indent, as it were, the margins of the furrow. Their armature consists of two short, subconical, sharply-pointed, or thorn-like spinelets, placed side by side on the aboral side of the projecting angle; they are consequently directed aborally and at an angle towards the furrow, diverging also slightly from one another.

The mouth-plates are rather large, forming an acute angle adorally, with an elevated angular ridge along the line of suture, each plate being strongly bent downwards, and having the upturned edges compressed together to form the keel. The aboral extremity is more elevated than any other part, and presents a sharp angular peak, the mouth-plates sloping down therefrom with a graceful inward curve to the level of the actinal interradial area. Their armature consists of a single short conical mouth-spine, placed at the extremity of the adoral peak; and two others, about equal in size to the spinelets of the adambulacral armature, stand on the lateral margins of each plate, the most adoral of the two being situated nearly midway between the extremities of the margin.

The actinal interradial areas, which are small and sagittiform in outline, do not extend beyond the third adambulacral plate. The intermediate plates are small and subregular, transversely elongate on the outer part of the area, and with a tendency to imbricate; this character, however, being so faintly presented that it is difficult to say whether imbrication really exists or not.

Colour in alcohol, greyish white generally, but rather darker over the abactinal area of the disk.

Locality.—Station 237. Off the coast of Japan, south of Kawatsu. June 17, 1875. Lat. 34° 37′ 0″ N., long. 140° 32′ 0″ E. Depth 1875 fathoms. Blue mud. Bottom temperature 35°·3 Fahr.; surface temperature 73°·0 Fahr.

Remarks.—Porcellanaster tuberosus is distinguished from the other species of *Porcellanaster* with only one cribriform organ in each interbrachial arc, by its broad and robust rays, with a large and tubercular terminal plate armed with three spines, and by having only two supero-marginal plates on each side of a ray armed with spines, which are stout. Other points of difference are noticed in the description.

4. *Porcellanaster crassus*, Sladen (Pl. XXII. figs. 4–7; Pl. XXVII. figs. 1–4).

Porcellanaster crassus, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 225.

Rays five. R = 35 mm.; r = 10·5 mm. R < 3·5 r.

The rays are elongate, robust, and taper gradually from the base to the extremity. The disk is small, but not high, and is only slightly inflated above the level of the

supero-marginal plates; the minor radius is in the proportion of 30 per cent. The interbrachial arcs are well rounded.

The abactinal area is much contracted in consequence of the inward arching of the marginal plates, the latter forming a broad border enclosing a regular pentagonal area when seen from above. The whole abactinal area, excepting a very small space at the base of the rays, is beset with simple spinelets, uniformly distributed over the surface and moderately well spaced, the spinelets being very small, short, cylindrical, and invested with membrane. In the interspaces between the spinelets, small papulæ may, with difficulty, be detected here and there; in external appearance they resemble the spinelets, but are rather larger and thicker. A broad tapering epiproctal tubular prolongation or anal funnel, about 3 mm. in length, is present near the centre of the disk.

The marginal plates are high, arch inward, and form a sloping or bevelled edge to the disk in the interbrachial arcs; and a similar inclination is also continued along the rays. The abactinal surface of the rays is consequently arched, and the supero-marginal plates of the two sides almost meet in the median line, being separated only by a narrow furrow. The actinal surface of the ray is flat. The supero-marginal plates are higher than long, and each bears a large robust spinelet nearly as long as the height of the plate. The innermost spinelet, on each side of the median interradial line, is smaller than any of the others. There are seven supero-marginal plates from the median interradial line to the tip of the ray, exclusive of the terminal plate. This latter is large and very prominent, compressed laterally, high, tubercular, and rounded abactinally, and bears four spines—one placed in the median line above the termination of the ambulacral furrow, and one on each side of the furrow at a lower level, all the three being close together at the very extremity, whilst the fourth spine is placed in the median line well back on the tubercular elevation of the terminal plate.

The infero-marginal plates, which are nine in number, are longer than high, and do not curve round on the actinal surface, but rise abruptly at a sharp angle to it. At the extremity of the ray there are occasionally two or three small irregular supplementary plates intercalated between the superior and inferior series, but they in no way interfere with the form or position of the terminal plate.

Three cribriform organs are present in each interbrachial arc, the median one being the broadest; they are well spaced, and each has a depression down the median line. The structure is lamelliform. (See Pl. XXVII.)

The ambulacral furrows are wide, straight, and open. The adambulacral plates are elongate in the direction of the ray, and their form simulates the appearance in outline of caudal vertebræ. Their armature consists of a single short curved spinelet, which is articulated at the adoral extremity of the margin, and usually directed transversely across the furrow, or sometimes at an angle more adorally, the curvature of the spine being downwards.

Midway between the extremities of the adambulacral plate is placed a small, thin, semicircular, scale-like papilla, with the straight base upon which it is articulated running parallel to the furrow, and having the rounded free lip directed outward. Each of these papillæ shuts down upon a small cavity or pit, the function of which is as yet unknown. The cavities are filled with very fine dark coloured matter, which may either be mud or excreted matter. I have spoken of these structures under the name of segmental pits and papillæ (*ante* p. 128; see Pl. XXVII. fig. 3).

The mouth-plates are large and prominent, the mouth-angle presenting a broad well-rounded keel. At the aboral extremity there is a graceful slope; the margins of the plate are united, and do not expose the odontophore. In the median line of the keel, however, midway between the extremities, a hollow elliptical space occurs where the margins of the plates do not meet. The adoral extremity is somewhat rounded, and a single short conical spinelet is borne at the union of the two plates, occasionally with a small secondary companion standing above it. No other mouth-spines are present on the plates. On the side of each mouth-plate two of the segmental pits and their papillæ are present; the aboral one is the larger of the two, and is placed rather nearer the aboral extremity than midway on the plate, the smaller pit and papilla being about equidistant between the adoral extremity of the mouth-plate and its larger companion. (See Pl. XXVII. fig. 2.)

The actinal interradial areas, which are very small and subtriangular, are covered with a leathery skin, through which the plating is scarcely discernible.

Colour in alcohol, yellowish grey, with a brownish shade near the disk, darkest near the borders of the area adjoining the marginal plates.

Locality.—Station 286. In the mid south Pacific, near the meridian of 135° W., approximately midway between Sydney and Valparaiso. October 16, 1875. Lat. 33° 29′ 0″ S., long. 133° 22′ 0″ W. Depth 2335 fathoms. Red clay. Bottom temperature 34°·8 Fahr.; surface temperature 63°·0 Fahr.

Remarks.—This form is distinguished from all the other species of *Porcellanaster* by its large robust rays, and by the presence of the segmental pits and papillæ. The only other species known to possess these organs has no spines on the superomarginal plates or only rudimentary ones, whilst in *Porcellanaster crassus* each superomarginal plate bears a thick well-developed spine.

5. *Porcellanaster gracilis*, Sladen (Pl. XXII. figs. 1–3; Pl. XXVII. figs. 5–8).

Porcellanaster gracilis, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 227.

Rays five. R = 10 mm.; $r = 4{\cdot}5$ mm. $R > 2r$.

The rays are rather long and slender, slightly tapering, and somewhat flattened. The disk is moderately high and inflated; the minor radius is in the proportion of 45

per cent. The interbrachial arcs are wide, and the immediate arm-angle is more or less straight.

The abactinal area is covered with a thin membrane. Spinelets, borne on spicule-like plates, are confined to bands along the interradial lines, and a few surround the epiproctal tube; the radial areas are entirely without spinelets. The spinelets are very minute, little more than microscopic spicules, elongate, cylindrical, not tapering, covered with a thin membrane through which the calcareous base and shaft are distinctly visible. The tubular epiproctal prolongation or anal funnel is moderately well developed, broad at the base, and tapers rather rapidly.

The marginal plates are not high, and form an almost perpendicular wall which bends inward very slightly; they do not arch over on the sides of the rays, and their curvature produces only a slight rounding of the margin. The abactinal area of the ray is flat, and the space which intervenes between the marginal plates of each side is covered with membrane. This band is nearly uniform in breadth throughout, and is equal to one-third of the greatest breadth of the ray; it extends up to the extremity, the adoral margin of the terminal plate being indented for its continuation. The supero-marginal plates are eight in number, counting from the median interradial line, and exclusive of the terminal. Their shape is nearly quadrate, the most inward and the most outward plates having the height rather greater than the length, whilst those midway present the reverse proportions. Each of the supero-marginal plates normally carries a minute tubercle or rudiment of an aborted spinelet, but in some instances even this is wanting. The terminal plate is not at all gibbous or tubercular, and its size and outline is conformable in every way to the regular tapering of the ray. Three small delicate spines are borne on the terminal plate—one placed at the extremity, in the median line, which points upward and outward, and one on each side at a lower level, which are separated by the furrow and directed horizontally and radiate slightly outward from the axial line of the ray.

The infero-marginal plates correspond in number to the superior series and, excepting the innermost plate, have the length greater than the height.

Three cribriform organs are present in each interbrachial arc, the lateral ones are very narrow, and all are well spaced. Their structure is lamelliform. (See Pl. XXVII.)

The ambulacral furrows are wide, straight, or very slightly petaloid, and open. Each adambulacral plate bears a single spinelet, and also a rather large segmental pit and papilla. The spine, which is placed at the adoral extremity of the plate, is comparatively robust, cylindrical, slightly tapering, and longer than half the breadth of the furrow, over which it is directed horizontally and slightly inwards (adorally). The segmental papilla is subcircular in shape, nearly half as large as the whole adambulacral plate, and is situated midway between the bases of the spinelets on the two adjacent adambulacral plates, the margin towards the furrow being straight. (See Pl. XXVII. fig. 7.) Towards

the end of the ray the papillæ are turned back and directed slightly over the furrow, instead of being closed down upon the surface of the plate, and the pit is probably aborted.

The mouth-plates form a rather broad mouth-angle, presenting a well-developed keel along the median line of junction, more or less imperfectly closed along the suture and widely open at the aboral extremity. A single, short, conical, sharply pointed mouth-spine to each mouth-angle stands at the innermost point, and in the median line. Two large segmental papillæ occupy nearly the whole of the lateral portion of each mouth-plate; they stand close together, touching one another, and the aboral one is the larger of the two. (See Pl. XXVII. fig. 6.)

The actinal interradial areas are small, and the squamous intermediate plates are comparatively few in number, these being rather large in the immediate angle, though very narrow and elongate near the margin.

Colour in alcohol, greyish white, excepting the abactinal membrane, which is bluish grey.

Locality.—Station 298. Off the western coast of South America, between Valparaiso and the Island of Juan Fernandez. November 17, 1875. Lat. 34° 7′ 0″ S., long. 73° 56′ 0″ W. Depth 2225 fathoms. Blue mud. Bottom temperature 35°·6 Fahr.; surface temperature 59°·0 Fahr.

Remarks.—This species is distinguished from *Porcellanaster crassus*, the only other form having segmental pits and papillæ, by its short and delicate rays, by its comparatively unarmed supero-marginal plates, and by the limitation of the spinelets on the abactinal surface to definite areas.

6. *Porcellanaster eremicus*,[1] n. sp.

Since my preliminary notices on the species of *Porcellanaster*[2] were written I have received a very young form which had been found in a bottle of other material that had been sent to America. It is without doubt a *Porcellanaster*, and at a very early stage of growth. The measurements are R = 6·5 mm.; $r = 3{\cdot}25$ mm. The form appears to be nearly related to *Porcellanaster cæruleus*, and the most striking, if not the only real specific difference that I can detect at this stage is that the rays are longer, more attenuate, and thinner throughout.

At such an obviously early phase it would serve no good end to endeavour to draw up a specific diagnosis which would enable the adult stages to be recognised when found. I shall therefore limit myself to some remarks on the interesting features presented by this example. As I feel convinced, however, from the characters shown by the young form, and from the isolation of the habitat, that the species is distinct, I have ventured to assign a name to it. This course will also facilitate reference.

[1] ἐρημικός, accustomed to solitude.

[2] *Journ. Linn. Soc. Lond.* (Zool.), 1883, vol. xvii. p. 214.

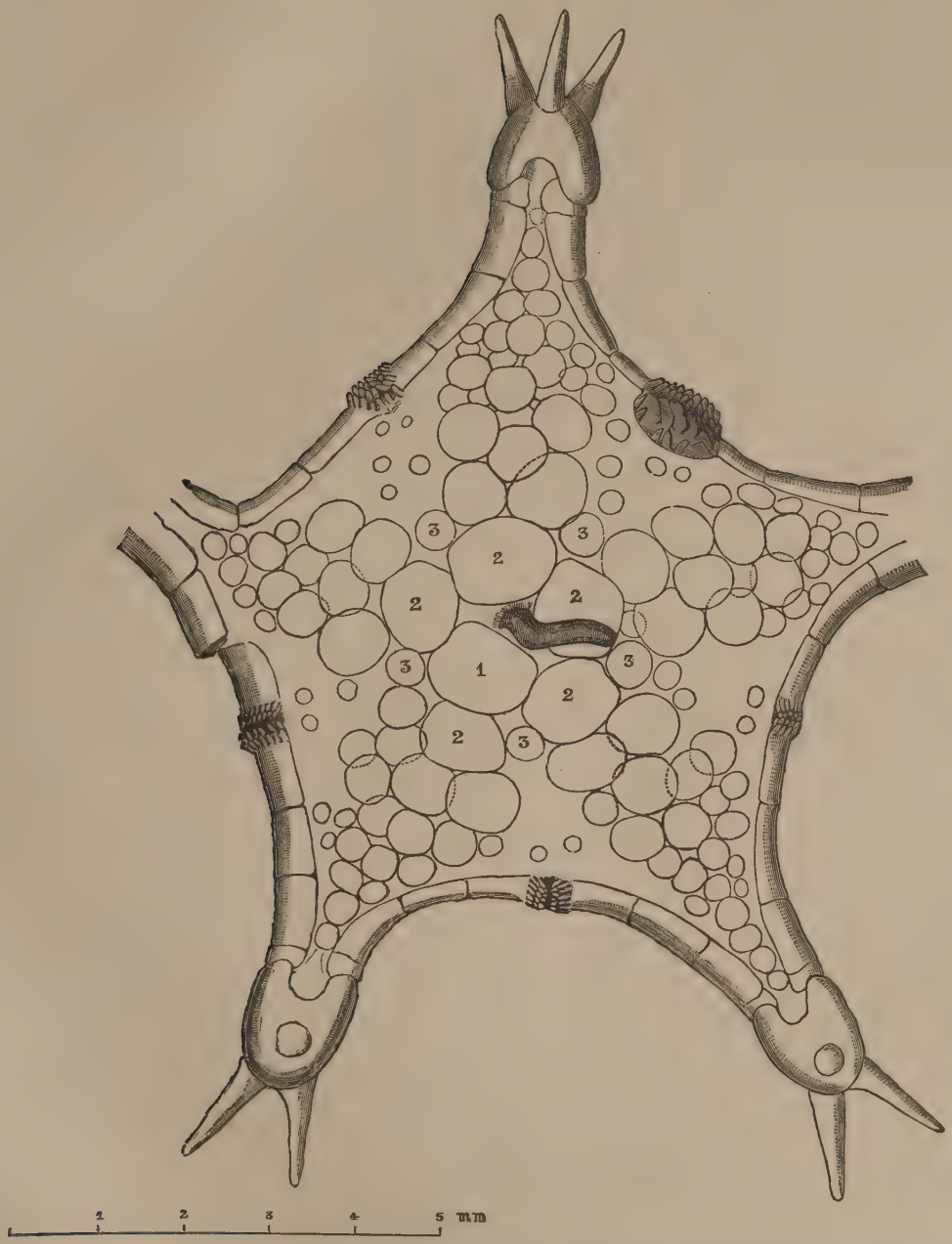
The whole abactinal area is covered with large subcircular or irregularly oval plates, perforated throughout with circular holes; the drawing of the larval plates of another form on Pl. XXVI. fig. 6 indicates their character. The primary apical plates are large and very distinct; their relative proportions and arrangement will be better understood by a glance at the accompanying woodcut than by a lengthy verbal description. The sketch was made by myself with a camera lucida, and represents the exact form and position of the plates as seen under the microscope, without the slightest subsequent alteration or attempt at diagram-making. The large dorso-central (1) and the proximal cycle of five large contingent plates (2, 2) are most conspicuous. The latter are radial in position, and appear to me to be the representatives of the under-basals of a Crinoid. If this view be correct their size and development is very remarkable. It also seems to be somewhat at variance with what is generally the order and proportion of development in other Asterids,[1] though hardly enough is known at present about the early stages of the group as a whole to warrant any dogmatic and positive statements to be formulated. External to the cycle of under-basals (2, 2) are five small circular plates (3, 3), interradial in position, and hence homologous with the basal plates. These plates have quite a different aspect from any of the others, and are much stronger and more compact in their structure. The radial plates are separated from the basals and from the under-basals by two or sometimes three intermediate plates, and can scarcely be distinguished by their size from the general plating. The abactinal interradial areas are almost devoid of plates, only a few isolated and very small ones being present. They appear to be the plates which bear spinelets, and they show a tendency to become crowded towards the margin, near the cribriform organ. In the centre of the disk is a small space, enclosed by the dorso-central and four under-basal plates, occupied by membrane, and from this springs the small but elongate tubular anal funnel.

The madrepodriform body is at the extreme margin, and is embraced as it were by the cribriform organ. There is one cribriform organ in each interbrachial arc; these are already well developed, and have about two rows of modified spinelets on each side of the interradial sutural line, which will ultimately form "lamellæ."

There are four supero-marginal plates between the median interradial line and the terminal plate, the one next to the terminal being much smaller than the others, and all except the one next the terminal are longer than high. The infero-marginal plates are very low, but subequal in length to their companion supero-marginal plate; in comparison with these, they appear mere band-like strips, and this circumstance might probably lead M. Perrier[2] to think that only one series of marginal plates was present in the examples he described under the name of *Caulaster pedunculatus*, if the same dispro-

[1] On the Homologies of the Primary Larval Plates of Brachiate Echinoderms, *Quart. Journ. Micr. Sci.*, 1884, n. s., vol. xxiv. p. 29.

[2] *Comptes rendus* (Dec. 1882), t. xcv. p. 1380.



Porcellanaster eremicus, n. sp. Outline sketch of a young example, to show the abactinal plating. Magnified 13 diameters. The following primary apical plates are indicated by numbers :—1. Dorso-central ; 2, 2. Under-basals ; 3, 3. Basals.

portion occurs in that form. Furthermore, the height of the infero-marginal plates diminishes as they proceed along the ray, and the outermost plate has the shape of a thin elongate wedge. There are only three infero-marginal plates between the median interradial line and the extremity, and there is no trace of an infero-marginal plate below or corresponding to the small supero-marginal plate next the terminal. The vertical sutures between the infero-marginal plates do not fall exactly below or in line with the sutures of the superior series. The terminal plate is extraordinarily large, and elevated conically towards the extremity. On this elevation is borne a vertical spine. At the extremity of the plate are two similar spines, one on each side of the median line, directed horizontally and radiating slightly apart.

The adambulacral plates are large, and already show the characters of an adult *Porcellanaster;* it may be noted, however, that they appear to be set somewhat obliquely. Each plate bears two spinelets on the furrow margin, side by side, and radiating a little apart. The spinelets are short, but broad and flattened, and rather leaf-like or lanceolate in form.

The mouth-plates are markedly coulter-shaped, the adjacent edges of each plate in a pair being turned up vertically, forming a high-crested keel, and the suture is not closed, but often gaping more or less. The armature consists of a single spinelet at the junction of the two plates and two spines on the margin of each plate, resembling in this respect the adult of *Porcellanaster cæruleus.* The odontophore is exposed on the actinal surface, having superficially the form of an equilaterally triangular wedge which fits in the angle formed by the aboral and unclosed ends of the two mouth-plates.

The actinal interradial areas are covered with an extremely delicate semi-transparent membrane in which no trace of actinal intermediate plates is yet to be detected.

Locality.—Station 137. In the South Atlantic, midway between the Island of Tristan da Cunha and the Cape of Good Hope. October 23, 1873. Lat. 35° 59′ 0″ S., long. 1° 34′ 0″ E. Depth 2550 fathoms. Red clay. Bottom temperature 34°·5 Fahr.; surface temperature 56°·1 Fahr.

Remarks.—This small form is apparently nearly related to *Porcellanaster cæruleus* of the North Atlantic, but may be distinguished by the more elongate and attenuate rays, even when compared with a rather larger young example of that species. Excepting these characters and the purely embryonic structures described above, the figures of the young phase of *Porcellanaster cæruleus* on Pl. XX. figs. 6, 7, represent the general aspect of the young form under notice so well that I have not considered it necessary to give additional drawings. For the general proportions and composition of the abactinal area the woodcut on the preceding page will supply what is requisite.

The striking manner in which the general structure of this young example agrees with the description given by Perrier of the form he has named *Caulaster pedunculatus* has already been noticed, and it supports my strong conviction that the latter will ultimately prove to be a young *Porcellanaster.*

In a recent paper on the starfishes collected during the "Talisman" Expedition, M. Perrier[1] still maintains *Caulaster* as a distinct genus, and mentions the occurrence of a second species, with which he has done me the honour of associating my name. Unfortunately, however, no additional information is given on the structure of *Caulaster*. Under these circumstances I feel assured that M. Perrier will acquit me of any undue pertinacity in still upholding the opinion I expressed in 1883,[2] confronted as I am now with the structure of *Porcellanaster eremicus*. No other course seems open to me, and I am therefore reluctantly obliged to follow it so long as the present state of insufficient information on the generic characters of *Caulaster* exists.

The only remark upon the genus made by Perrier in the paper referred to is as follows:—"Les *Caulaster* (*Caulaster pedunculatus*, E. P., *Caulaster Sladeni*, E. P.) sont caractérisés par l'absence presque complète du squelette dorsal, représenté seulement par cinque bandelettes épineuses descendant du pédoncule dorsal et exactement interradiales."[3] This limitation of the spinelets on the abactinal area to interradial bands occurs in two of the species of *Porcellanaster* known to me (and mentioned in my Preliminary Notices),[4] and is especially characteristic of the type of the genus, *Porcellanaster cæruleus*.

Genus *Styracaster*, Sladen.

Styracaster, Sladen, Journ. Linn. Soc. Lond. (Zool.), 1883, vol. xvii. p. 229.

Rays five, long and attenuate, incapable of being reverted.

Supero-marginal plates meet in the median radial line, and encase the ray; they bear long, robust, cylindro-conical spines, which form a single series along the median radial line.

Abactinal area covered with membrane, beset with simple spiniferous spicules or with pseudo-paxillæ. Usually no specially developed epiproctal prolongation is present, but a more or less definite conical elevation may be formed.

Actinal interradial areas paved with thin, smooth plates, arranged in regular columns, more or less clearly imbricating, and covered with a delicate membrane.

Ambulacral furrows narrow and more or less enclosed. Armature of the adambulacral plates consisting of elongate needle-shaped spines, and with a tendency to radiate apart.

Cribriform organs three to seven in number in each interbrachial arc.

Remarks.—The form mentioned by Perrier,[5] under the name of *Machairaster pictus*, as allied to *Porcellanaster*, but of which no generic diagnosis or description has yet been published, beyond the remark "à bras carénés et portant des épines sur la carène,"

[1] *Comptes rendus*, 1885, t. ci. p. 886.
[2] *Journ. Linn. Soc. Lond.* (Zool.), 1883, vol. xvii. p. 217.
[3] *Loc. cit.*, p. 886.
[4] *Journ. Linn. Soc. Lond.* (Zool.), 1883, vol. xvii. p. 214.
[5] *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi. p. 272.

may perhaps prove to belong to this genus, or be nearly allied. The information, however, is too meagre to hazard even a conjectural opinion.

M. Perrier[1] records the presence of two species of *Styracaster* amongst the Asteroids collected by the "Talisman" Expedition. He states that "une de nos espèces (*Styracaster spinosus*, E. P.) présente un pédoncule dorsal; l'autre (*Styracaster Edwardsi*, E. P.) n'a qu'un simple tubercule, mais chacun de ces bras porte sept épines sur la ligne médiane dorsale." No further remark is made and no description is given of the species; I am therefore unable to consider them. The second species mentioned would seem to resemble *Styracaster horridus*.

Chorology of the Genus Styracaster.

α. *Geographical distribution:*—

Atlantic: One species between the parallels of 0° and 10° S.

Styracaster horridus, between the south coast of Africa and the Island of Ascension.

Pacific: One species between the parallels of 0° and 10° N.

Styracaster armatus, in the neighbourhood of the Caroline Islands.

β. *Bathymetrical range:* 1850 fathoms to 2350 fathoms.

Both species are confined to the Abyssal zone.

γ. *Nature of the Sea-bottom:* Both *Styracaster horridus* and *Styracaster armatus* are found on Globigerina ooze.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Styracaster armatus. . .	Pacific.	1850	Globigerina ooze.
Styracaster horridus. . .	Atlantic.	2350	Globigerina ooze.

1. *Styracaster horridus*, Sladen (Pl. XXIII. figs. 5–7; Pl. XXVII. figs. 17–20).

Styracaster horridus, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 229.

Rays five. R = 75 mm.; r = 15 mm. R = 5 r.

Rays very long and slender, compressed laterally, and tapering to the extremity. The disk is not high, although capable of being inflated to a slight extent above the level of the marginal plates. The minor radius is in the proportion of 20 per cent. The

[1] *Comptes rendus*, 1885, t. ci. p. 886.

interbrachial arc is very wide, and its rounding is more or less obliterated by the subpentagonal character of the disk.

The abactinal area is covered with a leathery integument, beset with minute, compact, and closely crowded pseudo-paxillæ, composed of from four to eight spinelets, which occupy the whole area. The paxillæ are smaller in the immediate centre of the disk, but there is no special protuberance. The actinal portion of the disk slopes downwards, with an inward-bending curve from the margin to the mouth-plates, producing a very prominent convexity on the under surface.

The marginal plates are deep and almost vertical. Along the whole of the ray beyond the disk the supero-marginal series of each side meet, and from being bent inwards very slightly, produce the laterally compressed and high-arched character of the ray. The supero-marginal plates are twenty-three in number on one side of a ray, and all the plates are longer than high. Along the whole of the free portion of the ray each alternate supero-marginal plate bears a long sharply pointed spine on its upper edge, and the spine-bearing plates of the two sides of a ray alternate, the unarmed plate of the one side corresponding to the armed plate of the other; hence it follows that a straight single line of vertically directed spines extends along the whole of the median radial line. The spines are robust at the base, conical, and taper to a very finely pointed extremity. The spines are longer than the depth (height) of the ray, and they normally decrease in size as they proceed outwards, but the regularity of this is sometimes broken by the occurrence of a shorter spine here and there. The spines are slightly curved in the plane of the direction of the ray, the point turning outwards. Occasionally a small additional spine is intercalated here and there, in the otherwise equally spaced series, in consequence of the corresponding plate of the opposite side of the ray also bearing a spine. The terminal plate is rather large, compressed, and elongate, its abactinal surface sloping upwards at an angle of 45° from the general abactinal line of the ray, and its actinal surface is rounded, thereby emphasising the character of the upturned tip of the ray. The terminal plate bears three spines—one at the extremity in the prolongation of the median radial line, and one on each side at a lower level on the furrow margin, all quite at the extremity and close together. In a large specimen an additional spine is present, larger than the terminal abactinal one, and is placed behind it in the median abactinal line of the plate.

The infero-marginal plates are much shallower than the superior series, their length being nearly twice their height. In large specimens they frequently alternate with, instead of corresponding to, the companion supero-marginal plate, especially on the outer part of the ray; and sometimes an intermediate lateral series of plates almost as large as the infero-marginals is intercalated between the superior and inferior series and entirely separates them. This intermediate series may be represented by only a few plates on the outer part of the ray, or may be continuous along a considerable portion of the ray.

From seven to nine cribriform organs are present in each interbrachial arc; they are wide and occupy nearly the whole of the plates, in large examples adjacent organs being confluent in the neighbourhood of the horizontal suture. Their structure is papilliform. (See Pl. XXVII. fig. 20.)

The ambulacral furrows are wide when expanded, occupying the whole of the actinal aspect of the ray, but when contracted are arched over and closed in by the adambulacral armature. The adambulacral plates are elongate and subrhomboid, the margin towards the furrow and the actinal surface being incurved—suggestive of the appearance of a caudal vertebra. The armature of the adambulacral plates along the greater portion of the ray consists of four spines, the aboral spine being the longest; near the mouth, however, there are five spines, which are short and subequal. The spines are comparatively short, with a wide robust base, thence they taper, are sharply pointed, and slightly compressed, and all radiate at different angles from the plate. On the plates near the mouth the spines are much shorter, subequal, rapidly pointed, and quite flat. The bases of these spines are united by a more or less continuous membrane. In large specimens a small granule is present behind the furrow series, on the actinal surface of the plate and close to its adoral extremity; near the mouth even two or three are sometimes found.

The mouth-plates are large and prominent, with a widely open median suture, the apposed margins of the plates being bent downward with a gentle curve until at right angles to the actinal surface. Their armature consists of a comb of seven or eight short flat spinelets, similar to those on the innermost adambulacral plates, situated on the margin of the plate adjacent to the furrow, and there are one or two more prominent and conical ones at the innermost extremity, which are directed towards the centre of the actinostome. No spinelets or tubercles are normally present on the actinal surface of the mouth-plates, although in the largest specimen four or five granules form a line parallel to the sutural margin. The aboral extremities of the mouth-plates are widely open, and the odontophore is exposed superficially.

The actinal interradial areas are large and elongate in the direction of the median interradial line; they are paved with squamous intermediate plates, the whole being covered with a thin membrane. The plates are broader than long, imbricate slightly, and are arranged more or less in columns, which latter may however become somewhat irregular as they approach the mouth-angle, consequent on the increase in the size of the plates, which are also more irregular in shape there. A few small granules, very widely and irregularly placed, occur on the plates here and there.

Colour in alcohol, greyish white, the paxillar area and the cribriform organs having a slightly brownish tinge.

Locality.—Station 346. Between the south coast of Africa and the Island of Ascension. April 6, 1876. Lat 2° 42′ 0″ S., long. 14° 41′ 0″ W. Depth 2350 fathoms. Globigerina ooze. Bottom temperature 34°·0 Fahr.; surface temperature 82°·7 Fahr.

2. *Styracaster armatus*, Sladen (Pl. XXIV. figs. 1–4; Pl. XXVIII. figs. 1–4).

Styracaster armatus, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 232.

Rays five. R = 38 mm.; $r = 11$ mm. $R < 3{\cdot}5\ r$.

Rays long and slender, subcylindrical, nearly uniform in thickness throughout their length, the expansion at the base and the attenuation at the tip being very slight. The disk is depressed, not inflated, and not higher than the marginal plates; the minor radius is in the proportion of 28 per cent. The interbrachial arcs are very wide, with the curve somewhat flattened in conformity with the pentagonal character of the disk.

The abactinal area is covered with a leathery integument beset with minute imperfect pseudo-paxillæ, and simple spiculate spinelets closely crowded, the general appearance being that of spinelets only. Naked spaces occur at the base of the rays. No definite epiproctal protuberance is present, but a faintly elevated indication of the centre may be discerned.

The marginal plates are high, curving slightly inward above and below, and forming a rounded margin. The supero-marginal plates are nine in number from the median interradial line to the extremity, exclusive of the terminal, and all are considerably longer than high. Along the rays, commencing at the fourth plate from the median interradial line, the supero-marginal plates on each side meet in the median radial line and entirely encase the upper portion of the ray. The ray is rather compressed laterally, and the abactinal surface is arched. Each alternate supero-marginal plate along the ray bears a large robust conical spine placed in the median line of the ray, the series forming a single line of five spinelets, which stand perpendicular to the ray and diminish in size as they proceed outward. Unfortunately many of the spines have been damaged, but the longest remaining one measures about 6 mm., and the tip appears to have been broken. The penultimate supero-marginal plate is small, and the ray is slightly bent upwards at the extremity. The terminal plate is small and comparatively inconspicuous, not at all swollen or tubercular, and is less than the pair of ante-penultimate supero-marginal plates. It bears three spinelets, one in the median line above the extremity of the ambulacral furrow, and two beneath, all close together.

The infero-marginal plates correspond in number to the superior series, but their length is very much greater in relation to their height—fully three times. The four outermost plates do not correspond in length to the companion supero-marginal series.

Three cribtiform organs are present in each interbrachial arc; they are rather broad, but well defined, and their structure is papilliform. (See Pl. XXVIII. fig. 4.)

The ambulacral furrows are very narrow and quite closed in by the overarching adambulacral plates and spinelets. The adambulacral plates are elongate and vertebra-like, the margin towards the furrow being deeply scooped out, whilst the extremities are prominent and thickened. The armature of the adambulacral plates consists of three spines, which are moderately long, sharply tapering, and slightly compressed: two stand near the

adoral extremity of the margin, equal in length, stretching over the furrow, and radiating apart from one another; the third spinelet is slightly smaller, placed about midway on the margin of the adambulacral plate, and is directed in the same direction as the aboral of the two spines. The spinelets are invested with a very fine membrane, which is continuous at their bases, and the spinelets of one side of the furrow interlock with those from the other. Behind the furrow series, at the adoral end of the plate, and standing on the prominent swelling, away from the margin of the furrow, a small conical spinelet rises perpendicularly from the surface of the plate; and this becomes more or less rudimentary as it proceeds along the free portion of the ray.

The mouth-plates, which are large, prominent, and not united along the median suture, have a peculiar appearance, resembling the shape of a coulter in a marked degree. Their armature consists of five or six mouth-spines placed side by side along the lateral margin of the plate, similar in length and character to the spinelets constituting the armature of the adambulacral plates, and these interlock with the corresponding series of spines of the neighbouring mouth-angle. About three small, aborted, tubercular spinelets situated on the surface of the plate are probably the representatives of secondary mouth-spines. The plates of each pair of mouth-plates are wide apart, and being unclosed at their aboral extremity, expose the odontophore.

The actinal interradial areas are rather large and triangular, covered with squamous intermediate plates, which are narrow, elongate, imbricating, and regularly arranged in columns on the outer half of the area, but become larger, broader, subrotund, and irregular as they approach the mouth-angle. The plates are smooth, without granules, and the investing membrane is of such remarkable thinness that its presence is almost questionable.

Colour in alcohol, grey, with a slightly brownish shade over the paxillar area.

Locality.—Station 224. In the neighbourhood of the Caroline Islands, 100 miles north of the Admiralty Islands. March 21, 1875. Lat. 7° 45′ 0″ N., long. 144° 20′ 0″ E. Depth 1850 fathoms. Globigerina ooze. Bottom temperature 35°·4 Fahr.; surface temperature 81°·2 Fahr.

Genus *Hyphalaster*, Sladen.

Hyphalaster, Sladen, Journ. Linn. Soc. Lond. (Zool.), 1883, vol. xvii. p. 234.

Rays five, short, incapable of being reverted. Disk more or less depressed and pentagonal.

Supero-marginal plates devoid of spines, sometimes uniting in the median radial line, and enclosing the ray.

Abactinal membrane with pseudo-paxillæ; simple spinelets also present in some forms on the outer part of the area only. A conical epiproctal protuberance may be more or

less defined in the centre of the disk, similar to that present in some species of *Astropecten*, but is usually more conspicuously developed, although it does not attain the tubular form of this appendage found in *Porcellanaster*.

Actinal interradial areas extensive, paved with numerous thin intermediate plates arranged in regular columns and imbricating.

Ambulacral furrows narrow and concealed. Armature of the adambulacral plates consisting of short compressed spines, three to five in number, usually forming a kind of fan or independent series on each plate.

Cribriform organs five to seven (or nine[1]) in number in each interbrachial arc.

Synopsis of the Species included in the Genus Hyphalaster *herein described.*

A. Five cribriform organs in each arc. Abactinal area with prominent groups of paxillæ .	*diadematus.*
B. Seven cribriform organs in each arc. No prominent groups of paxillæ on the abactinal area.	
a. Supero-marginal plates meet in the median line. Cribriform organs very narrow. Secondary row of granules behind the furrow series of spines on the adambulacral plates aborted or absent.	
a. Disk with very imperfect pseudo-paxillæ. Two innermost supero-marginal plates on each side of the median interradial line with small spinelets. Mouth-plates with secondary mouth-spines. Body frame very thin and delicate .	*hyalinus.*
b. Disk with fully developed paxillæ. No spinelets on the supero-marginal plates. No secondary mouth-spines. Body frame robust and rigid.	*inermis.*
b. Supero marginal plates not united in the median line. A series of small secondary granules behind the furrow series of spinelets in the armature of the adambulacral plates. Cribriform organs very broad and expanded	*planus.*

M. Perrier[2] mentions by name two starfishes which he refers to *Hyphalaster*, dredged in the Atlantic during the "Talisman" Expedition, from 2995 and 4787 metres respectively. This is an interesting extension of the range of the genus, as no representatives of it were found in the Atlantic during the Challenger Expedition. Unfortunately no descriptions of the species are given, and I am therefore unable to compare them with the present series. The following is the only information respecting them given (*loc. cit.*, p. 886) by M. Perrier:—"Les *Hyphalaster* (*Hyphalaster Antonii*, E. P., *Hyphalaster Parfaiti*, E. P.) ont leurs plaques adambulacraires de forme normale, et non pas obliques, par rapport à la gouttière qu'elles bordent; le premier a sept organes cribriformes, dont deux rudimentaires, mais il y a, pour chaque bras, neuf plaques marginales dorsales dont les quatre dernières se soudent à leurs symétriques; le second a neuf organes cribriformes."

[1] *Fide* Perrier, *Comptes rendus*, 1885, t. ci. p. 886.

[2] *Comptes rendus*, 1885, t. ci. p. 886.

Chorology of the Genus Hyphalaster.

α. Geographical distribution :—

Atlantic: Two species (*fide* Perrier).
Hyphalaster antonii and *Hyphalaster parfaiti.*

Pacific: Three species between the parallels of 40° N. and 40° S.
Hyphalaster inermis off the coast of Japan, south of Kawatsu. *Hyphalaster hyalinus* in the Mid-Pacific, due north of the Society Islands and due west of the Marquesas Islands. *Hyphalaster diadematus* off the west coast of South America, between Valparaiso and the Island of Juan Fernandez.

Southern Ocean: One species between the parallels of 50° and 60° S.
Hyphalaster planus near the meridian of 110° E.

β. Bathymetrical range: 1875 fathoms to 2750 fathoms.
All the species are confined to the Abyssal zone, and two (*Hyphalaster diadematus* and *Hyphalaster hyalinus*) to depths greater than 2000 fathoms.

γ. Nature of the Sea-bottom: Two species, *Hyphalaster diadematus* and *Hyphalaster inermis*, are found on Blue mud. *Hyphalaster planus* on Diatom ooze. *Hyphalaster hyalinus* on Radiolarian ooze.

Chorological Synopsis of the Species herein described.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Hyphalaster diadematus . . .	Pacific.	2160	Blue mud.
Hyphalaster hyalinus . . .	Pacific.	2750	Radiolarian ooze.
Hyphalaster inermis	Pacific.	1875	Blue mud.
Hyphalaster planus	Southern Ocean.	1950	Diatom ooze.

1. *Hyphalaster hyalinus*, Sladen (Pl. XXVI. figs. 1–6; Pl. XXVIII. figs. 13–16).

Hyphalaster hyalinus, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 235.

Rays five. R = 20 mm.; $r = 10$ mm. R = 2 r.

Rays short, small, rounded, and of uniform thickness throughout. The disk, although not high, is more or less inflated; the minor radius is in the proportion of 50 per cent. The interbrachial arcs are of great width, the curve being almost lost in the straightness of the side of the pentagonal disk.

The abactinal area is covered with a thin and almost transparent membrane, which is indurated with a great number of spiniferous spicules or pseudo-paxillæ. These consist of a circular scale-like base, from the centre of which a spine-like process rises vertically, and this may be divided into two, three, or four equal spinelets, the latter number being the most general in the centre of the disk, and those with one spinelet near the margin. The spinelets are moderately robust, obtuse, all united at the base, and radiating apart very slightly, have more or less the appearance of imperfect paxillæ, whilst the squamous basal plate is scarcely larger than the diameter of the vertical spinous process. These pseudo-paxillæ are rather crowded in the immediate centre of the disk, but are elsewhere moderately and uniformly well-spaced. There are no papulæ. The presence of an actual anal aperture is doubtful.

The marginal plates form a perpendicular wall of small but uniform height. The upper margin of the superior series and the lower margin of the inferior series are slightly bent inwards and form bevelled edges. The supero-marginal plates are eight in number, counting from the median interradial line, exclusive of the terminal. The innermost plates are nearly twice as long as high, and the outermost are higher than long. The two innermost plates on each side of the median interradial line each bear a single, very minute, conical spinelet near the upper margin, and directed horizontally. The two outermost supero-marginal plates extend to the median radial line, where they join the corresponding plates from the other side of the ray; the two next plates are separated by a narrow strip of the abactinal membrane with pseudo-paxillæ, and the remaining plates fall in the disk margin. The terminal plate is slightly tumid proximally, and tapers rapidly to a fine extremity, which is continued in a robust, sharply pointed, terminal spine. This spine, which is longer than the plate, is placed in the median radial line of the ray, and is directed outward and slightly upward from the horizontal; two smaller spinelets less than half the size of the above are placed at a lower level, one on each side of the extremity of the furrow.

The infero-marginal plates correspond in number and breadth to their superior companions; their height is less than the length, and varies very slightly throughout the ray.

Seven cribriform organs are present in each interbrachial arc; they are very narrow, and the outermost are almost imperceptible. Their structure is papilliform. (See Pl. XXVIII.)

The ambulacral furrows are narrow and entirely closed in by the overarching plates and spinelets. The adambulacral plates are large and subcrescentric in form, with the extremities truncate and the incurved margin directed towards the furrow. Their armature consists of three spines to each plate, which are moderately long, slightly tapering, obtuse, and rather compressed, covered with very delicate membrane, which near the base unites with that of the adjoining spines, and forms a rather broad continuous web, by which the spines are bound together in continuous series. The spines

are confined to the adoral or inner two-thirds of the plate. Three to five small aborted spinelets, little more than granules, stand upon the surface of the plate behind and external to the furrow series, and form an aborted secondary series. The adambulacral plates are separated throughout the ray from the marginal series by a narrow strip of membrane with scale-like plates continued from the actinal interradial area.

The mouth-plates are large, prominent along the line of suture, forming a broad well-elevated keel in which nearly the whole of the two plates is involved. The aboral extremity slopes gradually, the surface of the actinal interradial area being inclined upward to meet it, and adorally they also likewise slope gradually. The sutural junction is imperfect, and widely expanded aborally, exposing the odontophore. The armature of the mouth-plates consists of six mouth-spines proper on each plate, *i.e.*, twelve for the whole mouth-angle; the innermost one is much larger and more robust than the others, and there are thus two large spinelets at the innermost point of each mouth-angle directed over the actinostome. The five smaller spinelets, which are uniform, equal, and less than the spines forming the armature of the adambulacral plates, are arranged equidistantly along the lateral margin of the plate, and arch over the furrow in continuation of the spinelets on the adambulacral plates. About three aborted secondary spines are placed close to the margin of the plate, which falls in the median suture; the middle one is largest, subconical, and stands nearest the highest point of the keel; the most adoral is similar in shape, but rather smaller, and is placed midway between this and the anterior extremity; whilst the outermost one is little more than a tubercular granule, and stands equidistant between the middle spine and the aboral extremity. Occasionally the adoral secondary spinelet is largest. A few irregular rounded granules may occur on the aboral portion of each plate.

The actinal interradial areas are expansive, covered with a thin transparent membrane, and with a compact plating of delicate imbricating scales. These scale-like intermediate plates are more or less regularly hexagonal, and are arranged in columns parallel to the median interradial line. The plates diminish in size and depth towards the margin, where they become narrow elongate strips. Each plate bears two or three small rounded granules irregularly disposed, and the large plates near the interior of the interradial area have a few additional granules in proportion to their size.

Colour in alcohol, greyish white, with a brownish or slightly orange shade over the abactinal membrane.

Young Phase.—There is a small specimen measuring R = 12 mm., $r = 5$ mm., which I consider to be the young of this species. The example in question is especially noteworthy on account of still possessing the embryonic plating on the disk. The plates, though large, are very irregular, and I have not been able to reduce them to any formula of arrangement; the illustration on Pl. XXVI. fig. 4 will give a fair idea of their form, size, and position.

The armature of the adambulacral plates consists of proportionally larger spines than in the adult, and these are conical and pointed, and radiate apart, as in other forms of *Hyphalaster*, instead of forming the almost straight uniserial line noticed in the adult of *Hyphalaster hyalinus*. The terminal plate is thick and blunt at the end.

If this really is the young form of *Hyphalaster hyalinus* it is extremely interesting to note (1) up to what a comparatively late stage of growth the embryonic planting is retained; and (2) that these large plates entirely disappear and do not become metamorphosed into other plates, but give place to the very minute and simple spiniferous *Thyonidium*-like spicules which pervade the whole of the then delicate semi-transparent abactinal membrane.

Locality.—Station 274. In the Mid-Pacific, due north of the Society Islands and due west of the Marquesas Islands. September 11, 1875. Lat. 7° 25′ 0″ S., long. 152° 15′ 0″ W. Depth 2750 fathoms. Radiolarian ooze. Bottom temperature 35°·1 Fahr.; surface temperature 80°·2 Fahr.

Remarks.—This species is distinguished from all the others by its remarkably delicate structure, the abactinal membrane appearing at first sight merely like a semi-transparent bag, by the mouth-plates bearing secondary spines, and by the two innermost superomarginal plates on each side of the interradial line bearing small spinelets.

2. *Hyphalaster diadematus*, Sladen (Pl. XXI. figs. 1–4; Pl. XXVIII. figs. 17–20).

Hyphalaster diadematus, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 237.

Rays five. R = 24 mm.; r = 10 mm. R < 2·5 r.

Marginal contour stellato-pentagonal. Rays well developed, slender, springing from the disk with a gradual taper, which is continued to the extremity; the upper surface of the ray arched rather than rounded. Abactinal surface of the disk slightly inflated above the level of the marginal plates, and with a prominent conical peak in the centre of the area. The minor radius is in the proportion of 41·6 per cent. Interbrachial arcs well rounded.

The abactinal area is covered with a thick integument, uniformly beset with well-spaced pseudo-paxillæ, which are very small and regular, each composed of three or four spinelets, those with the latter number being by far the most numerous. The paxillæ do not extend along the rays, but are confined to the actual disk-area; a blank space is thus left at the base of the rays, which has the appearance of being closely plated with small round scales imbedded in the integument. In the neighbourhood of the conical peak the paxillæ become very small and crowded. Around this as a centre, and at some little distance away, a number of larger paxillæ made up of more spinelets are arranged; these are congregated with more or less regularity into round groups, of which, roughly speaking, there is one opposite the median line of each ray, with a smaller group intermediate between each of the larger ones. The larger groups consist of ten to twelve large paxillæ of

about ten spinelets each, and the smaller groups of about five or six paxillæ. Outside this conspicuous ring of the disk there are a few large paxillæ placed here and there amongst the general small or pseudo-paxillæ of the disk.

The marginal plates, instead of forming perpendicular rounded sides, are inclined inwards, towards the centre, which gives a bevelled edge to the disk, and an arched rather than a rounded character to the upper surface of the rays. The supero-marginal plates do not meet in the median line of the ray, but leave a rather wide suture along the whole length, which expands on approaching the disk. All the marginal plates are longer than high, excepting perhaps the penultimate superior. The supero-marginal plates are ten in number exclusive of the terminal, and vary in depth very slightly from the median interradial line to the extremity of the ray.

The infero-marginal plates correspond in number and breadth to the superior series, but diminish gradually in height as they proceed along the ray. The surface of the plates is perfectly smooth, and forms an even contour-line to the ray, the sutures being scarcely discernible except with a magnifying glass. None of the supero-marginal plates bear spines except the terminal. This plate is comparatively small and inconspicuous, sub-triangular in contour, and upturned at a sharp angle to the plane of the ray, a position that gives a very marked character. It bears three rather short robust spines—one, which is somewhat the stoutest, is placed in the median radial line and directed vertically upwards; the other two stand at the anterior actinal angles of the plate, and are directed outward and at an angle of about 45° to the single spine; in consequence of the thinning off of the terminal plate, the bases of these lateral spines are not far removed from that of the abactinal spine; a deep indentation or sinus occurs between them, in which the ambulacral furrow terminates.

Five cribriform organs are present in each interbrachial arc; they are rather wide, and leave only a small band of the plate between adjacent organs, and each has a depression down the median line. Their structure is papilliform. (See Pl. XXVIII. fig. 20.)

The ambulacral furrows are deep and contracted, the adambulacral plates arching considerably over, and their armature covering in the area when disposed for that purpose. The adambulacral plates are elongate and subcrescentiform, and each forms an angular prominence on the sides of the furrow, the angles separating to a certain extent the tube-feet of neighbouring segments. The armature of the adambulacral plates consists of four short, thin, and compressed spines on each plate, uniform in breadth throughout, and rounded at the extremity, which are arranged in a straight or sometimes slightly curved line, and at a very slight angle to the furrow, the direction of the line being outward from the furrow. A secondary row of five or six small granules stands on the outer margin of the adambulacral plates behind the furrow series, placed in a slightly curved line, and these become more or less indistinct along the outer portion of the ray.

The mouth-plates are large, prominent, and elevated along the line of suture; the junction is imperfect, and the adoral extremities of the plates being widely open expose the odontophore. Their armature consists of six to eight mouth-spines on each plate, which are short, compressed, and pointed. The innermost one on each side is larger and longer than the rest, and is directed towards the actinostome; the lateral ones stand in the furrow and interlock with the corresponding denticles of the neighbouring mouth-angle. A number (varying from six to twelve) of small granule-like tubercles are present on the actinal surface of each plate; two, which are slightly largest, stand near the inner third of the plate, whilst the remainder are confined to the aboral half of the plate, and are sometimes arranged in two or three lines, and sometimes irregularly. It seems scarcely possible to rank these as secondary mouth-spines; and yet there can be little doubt that they are rudimentary or aborted representatives of these appendages.

The actinal interradial areas are triangular in outline, and covered with a regular plating of hexagonal, imbricating, scale-like intermediate plates arranged in columnar series extending from the margin to the furrow, parallel to the median interradial line. The plates are broader than long, the disproportion increasing as they approach the margin; they bear a few (three to five) small, widely spaced, irregularly disposed granules, some plates here and there having none.

Colour in alcohol, greyish white on the margins and actinal area; abactinal membrane bluish grey, with touches of light brown near the margin of the area and occasionally on the groups of paxillæ round the centre of the disk.

Locality.—Station 299. Off the western coast of South America, between Valparaiso and the Island of Juan Fernandez. December 14, 1875. Lat. 33° 31′ 0″ S., long. 74° 43′ 0″ W. Depth 2160 fathoms. Blue mud. Bottom temperature 35°·2 Fahr.; surface temperature 62°·0 Fahr.

Remarks.—*Hyphalaster diadematus* is distinguished from the other members of the genus by the prominent groups of larger paxillæ on the abactinal area of the disk (the character from which the name is derived), and by the presence of five cribriform organs.

The example of this species, which is figured on Pl. XXI., did not come into my hands until some time after the preliminary notice[1] of this group had been published. It was one of the two species which had been drawn under the direction of the late Sir Wyville Thomson before the collection was entrusted to me, and after his death the specimens had been mislaid amongst other things, and were lost sight of for some time.

The type which has been described is larger and differs slightly in several respects, but I see no reason to doubt for a moment that the two examples belong to the same

[1] *Journ. Linn. Soc. Lond.* (Zool.), 1883, vol. xvii. p. 237.

species; and I do not think it necessary to make an additional plate for the illustration of the larger specimen. The differences appear to me to be clearly due to age, and may be summarised briefly as follows :—

The smaller specimen, which measures R = 14 mm., $r = 7{\cdot}5$ mm., is shorter in the ray, the minor radial proportion being about 53·5 per cent., whilst in the larger example it is 41·6 per cent. The rays have also a more arched appearance abactinally. The disk in the smaller example is more inflated, and this causes the specimen to appear deeper in the lateral view. In the larger specimen, which is described, the larger paxillæ have a greater number of spinelets and are more numerous on the disk. The secondary row of small granules noticed on the outer margin of the adambulacral plates near the mouth in the larger example is not present in the smaller specimen, or only represented by mere rudiments on a few of the innermost plates. In like manner the small isolated granules noticed on the actinal intermediate plates of the larger specimen are very few and far between on the small one. Also the actinal intermediate plates are relatively deeper and less broad in the small form.

In the drawing of the abactinal view on Pl. XXI. fig. 1, the membranous area between the marginal plates of the two sides of the ray is rather too broad. In the specimen the sides of the ray are somewhat compressed, and the figure is a restoration to the supposed normal condition; but the breadth indicated appears to me certainly too great. The very striking groups of larger paxillæ are scarcely shown with sufficient emphasis, though the dark areas well represent their presence.

3. *Hyphalaster inermis*, Sladen (Pl. XXV. figs. 4–6; Pl. XXVIII. figs. 5–8).

Hyphalaster inermis, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 239.

Rays five. R = 20 mm.; $r = 8{\cdot}5$ mm. $R < 2{\cdot}5\,r$.

Marginal contour stellato-pentagonoid. Rays well developed, slender, round, and tapering but slightly. The disk is depressed, not inflated, and both the abactinal and actinal surfaces stand on a level with the edges of the marginal plates. The minor radius is in the proportion of 42·5 per cent. The interbrachial arcs are very wide and expansive, the curve being slightly flattened at the summit of the arc emphasises the marked pentagonal contour of the body-disk.

The abactinal area is covered with closely crowded paxillæ, the whole disk as well as the base of the rays being uniformly packed. The paxillæ are very fine and small, and are made up of about five to ten spinelets. Towards the margin they become smaller, and also in the centre, where they are very compact—a slightly prominent peak being formed as in *Ctenodiscus*. A slight elevation of the surface is present in the median radial line, opposite the base of each ray, and at about one-third of the distance from the margin to the centre.

The marginal plates occupy the entire lateral region, and represent the whole thickness of the animal, forming perpendicular walls regularly rounded above and below. Along the rays, the supero-marginal plates meet in the median radial line, and form a complete casing to the ray, which is well rounded, small, and tapers but slightly. The supero-marginal plates are eight in number (or, counting a very small aborted one, nine), exclusive of the terminal. The plates which fall in the margin of the disk proper have the length about equal to their height, but in those along the ray the height is greater than the length.

The infero-marginal plates correspond in number and in length to the superior series. In the interbrachial arc, along the disk proper, the height is about equal to the length, and the plates are uniform in size with the superior series. Towards the extremity of the ray the height diminishes gradually, and the length is greater than the height—a reversal of the relative proportions presented by the plates of the superior series. The marginal plates are smooth and bear no spines; but when examined microscopically have the appearance of being subgranular, and built up of a rather open network. The plates of both series are convex outwardly or tumid in a very slight degree, by which means the sutural divisions of the segments are clearly marked out, and a somewhat annulated appearance is given to the ray. The terminal plate is large and conspicuous, appearing somewhat tubercular when viewed in profile, and oval in contour when seen from above. This plate bears three short and rather robust spinelets—one at the terminal extremity of the plate, situated in the median radial line, pointing in the direction of the prolongation of the ray, and diverging but little from the horizontal. Below this spine, and at each side of it, on the angle formed by the actinal edge of the plate and the terminal extremity, is a somewhat smaller spinelet, pointing in the direction of the prolongation of the actinal margin of the plate.

Seven cribriform organs are present in each interbrachial arc. They are narrow and well defined, and their structure is papilliform. (See Pl. XXVIII. fig. 8.)

The ambulacral furrows are narrow and straight, almost completely closed in by the overarching adambulacral plates and spines, the tube-feet, which are arranged in simple pairs, being entirely concealed from view. The adambulacral plates are about half as broad as long, but diminish in size as they proceed outwards, and form along the ray triangular prominences projecting into the furrow. Each plate bears three or four spines, rather short, rapidly pointed, more or less compressed, invested with membrane, arranged in line along the furrow margin of the plate, and sometimes oblique to the course of the furrow. The row of spinelets can be raised at a right angle to the surface of the plate, so as to allow the tube-feet to be protruded. Traces of an aborted secondary or external spinelet, represented by a mere granule, may be detected at the adoral extremity of the adambulacral plate, away from the furrow series.

The mouth-plates are moderately large, the inner margins which fall in the median

suture being elevated so as to form a rounded elongate tubercular protuberance, the lateral margins being flattened out. Their armature consists of seven or eight mouth-spines on each plate, similar to those constituting the armature of the adambulacral plates, excepting the innermost one, which is much larger and stouter. Two large spines are thus conspicuous at each mouth-angle, and are directed towards the centre, the series entirely closing the actinostome, which is remarkably small. The small mouth-spines upon the margin of the plate interlock with those of the adjacent mouth-angle, and form a continuous series with the armature of the adambulacral plates. The rudiments of a secondary mouth-spine, represented by a thorn-like granule, occur on each plate, near the median suture, and at the highest portion of the keel.

The actinal interradial areas are triangular in outline, flat, extensive, and covered with imbricating scales of more or less regularly symmetrical hexagonal form. These plates are broader than long, and arranged in regular series of single columns extending from the margin of the disk to the ambulacral furrow. Their breadth diminishes somewhat as they approach the margin, and consequently that of the columns also. The adambulacral plates join up to the infero-marginal plates along the whole length of the free portion of the ray, and there is consequently no extension of the interradial area along the ray. The imbricating plates bear a few widely spaced miliary tubercles or large granules upon their surface, usually four or five to the plate, upon which, however, they have no definite arrangement.

Colour in alcohol, grey; the paxillar area being a much darker shade, which shows a strong contrast with the greyish white of the marginal plates.

Young Phase.—There is a small example of this species, which, though measuring only R = 10 mm., $r = 5$ mm., so closely resembles in all respects the characters of the adult, that there is not the slightest hesitation in determining it specifically. Beyond the fact that the rays are shorter, the terminal plate more tubercular and broader, and that a less number of supero-marginal plates on the two sides of a ray meet in the median radial line, I can scarcely detect a feature worthy of mention as differentiating the immature from the adult form; excepting the changes in size, proportion, and number which affect plates and appendages normally. There are five supero-marginal plates between the median interradial line and the terminal in the small specimen.

Locality.—Station 237. Off Japan, south of Kawatsu. June 17, 1875. Lat. 34° 37′ 0″ N., long. 140° 32′ 0″ E. Depth 1875 fathoms. Blue mud. Bottom temperature 35°·3 Fahr.; surface temperature 73°·0 Fahr.

Remarks.—*Hyphalaster inermis* is distinguished from the other species with seven cribriform organs by its robust and rigid body-frame, by the supero-marginal plates meeting in the median radial line, by these being devoid of spinelets, by the fully developed paxillæ, and by the narrow cribriform organs.

4. *Hyphalaster planus*, Sladen (Pl. XXV. figs. 1–3; Pl. XXVIII. figs. 9–12).

Hyphalaster planus, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 242.

Rays five. R = 35 mm.; r = 15 mm. R < 2·5 r.

Marginal contour stellato-pentagonoid. The rays are of moderate length, and comparatively slender from the disk outwards. The disk is depressed and not higher than the supero-marginal plates, although apparently capable of a slight inflation. The minor radius is in the proportion of 42 per cent. The interbrachial arcs are very wide and more or less flattened, which gives a strongly marked pentagonal aspect to the large disk.

The abactinal area is covered with small closely crowded paxillæ, which are limited to the disk proper, and extend very slightly upon the area at the base of the rays; the median abactinal area of the ray being covered with membrane beset with small squamiform plates. The paxillæ are small, and composed of four to six short and comparatively robust spinelets, and are so closely placed as to almost give the appearance to the disk of being coarsely granulated, when seen without a magnifying glass. A prominent conical epiproctal protuberance is present in the centre of the disk.

The marginal plates constitute the entire thickness of the animal, and form a well-rounded margin to the disk. Along the rays the supero-marginal plates of the opposite sides do not meet, but are separated throughout the whole extent of the ray by a median radial membranous area, beset with squamæ. The rays are comparatively slender and well rounded, having a cylindrical appearance, and proceeding somewhat abruptly from the angles of the disk. The supero-marginal plates are ten or eleven in number, exclusive of the terminal ocular plate. They are rather longer than high, excepting in the one or two outermost plates, where the proportions may even be very slightly reversed.

The infero-marginal plates correspond to the superior series, the length exceeding the height throughout the ray. The height of the plates of the inferior series is greater in the interbrachial arc than that of the superior series, whilst along the ray it is much less; and it is less also than one-half the length of the plate. There is a gradual but very striking diminution in the size of the plates of both series as they pass from the disk along the ray. The marginal plates are smooth and covered with a very fine membrane; and all are devoid of spines excepting the terminal ocular plate. The terminal plate is not large or conspicuous, its size being in serial proportion to the neighbouring supero-marginal plates; it forms a blunt obtusely rounded extremity to the ray, and its actinal portion is slightly curved upwards. It bears three spinelets, or representatives of such appendages—one, which is short, robust, and conical, placed at the extremity in the median radial line and directed vertically; and a pair, one placed on each side, at a lower level, but quite in front of the abactinal spine. The lateral spines are probably aborted, being, at least in the specimen under notice, little more than tubercles.

Seven cribriform organs are present in each interbrachial arc; they are very widely expanded, and cover nearly the whole of the plates, adjacent organs almost touching in the neighbourhood of the horizontal suture. Their structure is papilliform. (See Pl. XXVIII. fig. 12).

The ambulacral furrows are narrow, and when they are contracted and closed in by the spinelets the tube-feet are entirely hidden from view. The adambulacral plates are elongate and subrhomboid in form, and present an angular prominence towards the furrow, the adoral side of the angle being much shorter than the aboral; from this circumstance results a singularly elegant festooned appearance, when the furrow is viewed as a whole. The armature of the adambulacral plates consists of four spines, except close to the mouth, three being placed on the aboral facet of the furrow margin of the plate, and one on the short adoral facet. The three innermost plates of the furrow immediately succeeding to the mouth-plates have five or six spines, and the angular prominence into the furrow is less pronounced. The spines of the adambulacral armature are uniform in size and shape throughout the ray; they are small, short, flat, and terminated abruptly with a lanceolate point, and all are in connection at their base with the common investing membrane of the plate. On the actinal surface of the plate, behind the furrow series of spines, are three to five small granules, arranged in a slightly curved line, which appears to follow the rounded margin of the adoral extremity and the outer side of the adambulacral plate. The most adoral of these granules show a tendency to develop the flat and pointed form of the furrow series, and there is little doubt that they are the representatives of an actinal or secondary series.

The mouth-plates are large and prominent, each curving down in a coulter-like form until the margins which fall in the median line are at right angles to the plane of the actinal surface. The prominent median keel thus produced slopes with a regular curve adorally and aborally, its longitudinal profile being almost semicircular. The median suture is not closed, but rather widely open, and expanding towards the aboral extremity of the plates exposes a portion of the odontophore. Each plate bears a short, robust, conical-pointed spine at its innermost extremity, the companion spine of the adjoining plate standing parallel. There is thus a pair of short, but conspicuous mouth-spines directed towards the centre of the actinostome from each mouth-angle. The remaining mouth-spines, which are six in number, are uniform in size and shape with the spinelets of the adambulacral armature, and are arranged along the margin of the plate which abuts on the furrow. A few prominent granules are present on the surface of the mouth-plates, but do not in the specimen under description appear to be arranged in any definite order.

The actinal interradial areas are large and extensive, flat, and covered with oblong squamiform plates. On the outer portion of the area these plates are about twice as broad as long, and are arranged in columns parallel to the median interradial line.

In the neighbourhood of the mouth-angle, and adjoining the adambulacral plates, the actinal intermediate plates become larger and altered in form, and appear independent of the series of columns. The actinal interradial area is covered with a very fine and almost imperceptible membrane, plates and membrane together being so thin that traces of the internal organs of the starfish can be seen through them. A number of small irregularly disposed granules are distributed over the area, but seldom more than two or three are present on a plate, and they are often wanting. The imbrication of the plates appears to be very slight in this species, and is perhaps only present in the outer part of the areas.

Colour in alcohol, grey, with traces of a purple shade remaining here and there upon the paxillar area and on the rays.

Locality.—Station 157. In the Southern Ocean, near the meridian of 110° E. March 3, 1874. Lat. 53° 55′ 0″ S., long. 108° 35′ 0″ E. Depth 1950 fathoms. Diatom ooze. Bottom temperature 32°·1 Fahr.; surface temperature 37°·2 Fahr.

Remarks.—This species is at once distinguished from the other species with seven cribriform organs by the supero-marginal plates of the two sides of a ray not meeting in the median radial line, but in being separated by a band of membrane; and also by the presence of the secondary or actinal series of granules behind the furrow series on the surface of the adambulacral plates.

Genus *Thoracaster*, Sladen.

Thoracaster, Sladen, Journ. Linn. Soc. Lond. (Zool.), 1883, vol. xvii. p. 245.

Rays five, moderately long, cylindrical, and rigid. Disk large, and capable of slight inflation.

Supero-marginal plates united in the median radial line, forming a cylindrical encasement to the ray. Marginal plates devoid of spinelets.

Abactinal area covered with small closely crowded paxillæ. No central epiproctal protuberance present.

Actinal interradial areas extensive, paved with plates imbedded in membrane, and carrying numerous small, uniform, rather closely placed, papilliform granules or spinelets.

Ambulacral furrows narrow and enclosed. Armature of the adambulacral plates, consisting of short equal spines, ranged on the furrow margin of the plate, and forming a lineal series along the ray. The actinal surface or outer portion of the plate is occupied by small papilliform spinelets more or less definitely arranged.

Cribriform organs fourteen in number in each interbrachial arc, in the single species known.

Terminal plate small, inconspicuous, and unarmed.

Chorology of the Genus Thoracaster.

α. Geographical distribution:—

Atlantic: One species between the parallels of 20° and 30° N.

Thoracaster cylindratus off the west coast of Africa, between the Canary Islands and the Cape Verde Islands.

β. Bathymetrical range: 2400 fathoms.

γ. Nature of the Sea-bottom: Globigerina ooze.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Thoracaster cylindratus . . .	Atlantic.	2400	Globigerina ooze.

1. *Thoracaster cylindratus*, Sladen (Pl. XXIX. figs. 1–6).

Thoracaster cylindratus, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 245.

Rays five. R = 62 mm.; $r = 21$ mm. $R = 3\,r$.

Marginal contour stellate, with large disk and very narrow cylindrical rays, which taper to a point. The disk is slightly inflated, forming a convex surface of low curvature. The minor radius is in the proportion of 33·8 per cent. The interbrachial arcs are wide and well rounded.

The abactinal area is covered with small, compact, and closely crowded paxillæ, which are, however, confined entirely to the disk in consequence of the junction of the supero-marginal plates in the median line along the whole of the free portion of the ray. The paxillæ are very small, and composed of six to ten small spinelets closely appressed into a fascicule—the whole area appearing to the unaided eye almost like a uniformly granular surface. The paxillæ are a shade smaller in the centre of the disk, which they further define by their arrangement, although no prominent epiproctal peak is produced. The actinal area of the disk is slightly convex and slopes downwards at a small angle to the prominent mouth-plates.

The marginal plates are high, forming a gently rounded margin to the disk, the plates curving slightly inward towards the abactinal and the actinal areas respectively. When viewed from above they are seen to encroach on the abactinal area to a very slight degree, and still less on the actinal. Along the free portion of the ray the supero-marginal plates of the two sides of the ray meet in the median radial line and entirely encase the ray;

in consequence of the regular rounding of the plates, the ray assumes a perfectly cylindro-conical form, tapering to the tip, and suggesting the appearance of a delicate Belemnite.

The supero-marginal plates are forty-three or forty-four in number, counting from the tip of one ray to the tip of the neighbouring ray, exclusive of the terminal plates. A pair of marginal plates stands in the median interradial line, instead of a sutural division as usual in *Porcellanaster*. All the marginal plates are devoid of spines or tubercles; and in both the superior and inferior series the height is greater than the length throughout the ray.

The infero-marginal plates correspond exactly to the superior series, and their height may also be said to be equal. A few very small conical granules, evidently loosely attached, are present on the surface of the marginal plates, especially in those which border the disk, and are grouped chiefly near the actinal margin of the infero-marginal plates and the abactinal margin of the superior series. The terminal plate, which is very small and inconspicuous, is in no way gibbous, and does not interfere with the general outline of the conically tapering ray; it is entirely devoid of spines. Seen in lateral profile, the tip of the ray shows a faint tendency to an upward curve, produced by the slightly elevated position of the terminal plate and the curving upward of the actinal area.

Fourteen cribriform organs are present in each interbrachial arc; they are very narrow and their structure is papilliform. (See Pl. XXIX. fig. 6.)

The ambulacral furrows are narrow, and when in a state of contraction, entirely conceal the tube-feet. The adambulacral plates are longer than broad, but are quite inconspicuous, their form and even the divisional sutures being masked by the membrane and spinelets with which they are covered. The armature of the adambulacral plates consists of five spines on the furrow margin, and the series of these form a continuous straight line throughout the ray, without curve or break of any kind. These spines are short, robust, truncate at the extremity, and flat, their breadth being placed at right angles to the furrow, and all are equidistantly spaced apart. Behind the furrow series each adambulacral plate bears on its actinal surface two irregular series of smaller and subconically shaped spinelets, about three standing at irregular distances next to the inner spinelets, and about five in the outer series. Owing to their irregularity in number and position and their tendency to group, these outer spinelets do not form the definite continuous lineal series presented by the inner or furrow series of the adambulacral armature.

The mouth-plates are large, and the combined pairs form conspicuous tubercular prominences. The median suture is imperfectly closed and expands at the aboral extremity of the plates, exposing the odontophore. Along the free margin of the plate is disposed a series of six or seven mouth-spines, similar to the spines forming the armature of the adambulacral plates, the innermost being slightly largest. The surface of the plates bears

a number of spiniform granules, which are most robust and elongate on the adoral half of the plate. Beyond this, these appendages do not appear to present any special arrangement or to form definite series, and they impart a very echinulate aspect to the mouth-angles.

The actinal interradial areas, which are large, are covered with membrane and minute subspiniform, conical granules. These are small, numerous, rather closely placed, and distributed over the whole area; here and there a faint appearance of grouping may be observed, which seems to suggest the indication of the actinal intermediate plates. Of the actual outline, arrangement, or character of these plates no observations can be made, owing to the uniform and thick covering of membrane with which they are overlaid.

Colour in alcohol, yellowish white, the paxillar area having a rather browner shade.

Locality.—Station 89. Off the west coast of Africa, between the Canary Islands and the Cape Verde Islands. July 23, 1873. Lat. 22° 18′ 0″ N., long. 22° 2′ 0″ W. Depth 2400 fathoms. Globigerina ooze. Bottom temperature 36°·6 Fahr.; surface temperature 73°·5 Fahr.

Remarks.—I know of no other starfish with which this remarkable and elegant form can be confounded.

Subfamily Ctenodiscinæ, Sladen, 1886.

Genus *Ctenodiscus*, Müller and Troschel.

Ctenodiscus, Müller and Troschel, System der Asteriden, 1842, p. 76.
Anodiscus (? Valenciennes, M.S.), Perrier, Ann. Sci. Nat., 1869, 5e Sér., t. xii. p. 298.

I have on a preceding page (p. 125) stated my reasons for associating this genus with the Porcellanasteridæ, and I have also remarked on the presence of an extremely minute pore at the extremity of the epiproctal cone, which is more or less prominently developed in the centre of the abactinal area.

Chorology of the Genus Ctenodiscus.

a. Geographical distribution:—

Atlantic: Two species:—one between the parallels of 60° and 80° N., the other between the parallels of 30° and 60° S.

Ctenodiscus corniculatus off the Scandinavian and North American coasts, off Greenland, Spitzbergen, and Nova Zembla, and in the Kara Sea. *Ctenodiscus australis* off the eastern coast of the southern point of America.

Pacific: One species between the parallels of 40° and 60° S.

Ctenodiscus procurator off the western coast of the southern point of America.

β. Bathymetrical range: 7 fathoms to 1325 fathoms.

All the species extend into the Abyssal zone, but none of them are exclusively confined to it.

Greatest range of one species: *Ctenodiscus procurator*, 40 to 1325 fathoms.

γ. Nature of the Sea-bottom: *Ctenodiscus corniculatus* is found on variable bottoms; but usually on mud and soft clay; occasionally hard and shelly. *Ctenodiscus australis* is found on sand, and on Green sand in 600 fathoms. *Ctenodiscus procurator* has only been found hitherto on Blue mud.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Ctenodiscus australis	South Atlantic.	55 to 600	Sand; Green sand (600 fathoms).
Ctenodiscus corniculatus . . .	North Atlantic.	7 to 632	Mud and Soft clay; hard occasionally.
Ctenodiscus procurator . . .	South Pacific.	40 to 1325	Blue mud.

1. *Ctenodiscus corniculatus* (Linck), Perrier.

Astropecten corniculatus, Linck, 1733, De Stellis marinis, p. 27, tab. xxxvi., No. 63.
Asterias crispata, Retzius, 1805, Dissert. sist. species cognitas Asteriarum, p. 17.
Asterias polaris, Sabine, 1821, in Parry's Journ. of a Voyage for the Discovery of a N.W. Passage, &c., in 1819–20, Append., p. ccxxiii., pl. i. figs. 2, 3.
Asterias arancia, Dewhurst, 1834, Nat. Hist. of the Order Cetacea, &c., p. 283.
Astropecten polaris, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 180.
Ctenodiscus polaris, Müller and Troschel, 1842, System der Asteriden, pp. 76, 129.
Ctenodiscus pygmæus, Müller and Troschel, 1842, System der Asteriden, pp. 76, 129.
Ctenodiscus crispatus, Düben and Koren, 1846, K. Vet.-Akad. Handl., 1844, p. 253.
Anodiscus crispatus (? Val. M.S.), Perrier, 1869, Ann. Sci. Nat., 5e Sér., t. xii. p. 298.
Ctenodiscus corniculatus, Perrier, 1876, Révis. Stell. Mus., p. 380 (Arch. de Zool. expér., t. v. p. 300).

Localities.—"Porcupine" Expedition:

Station 82. In the Faeröe Channel. Lat. 60° 0′ 0″ N., long. 5° 13′ 0″ W. Depth 312 fathoms. Bottom temperature 5°·2 C.; surface temperature 11°·2 C.

Station 57.[1] In the Faeröe Channel. Lat. 60° 14′ 0″ N., long. 6° 17′ 0″ W. Depth 632 fathoms. Bottom temperature −0°·8 C.; surface temperature 11°·1 C.

Station 58.[1] In the Faeröe Channel. Lat. 60° 21′ 0″ N., long. 6° 51′ 0″ W. Depth 540 fathoms. Bottom temperature −0°·6 C.; surface temperature 10°·6 C.

[1] This occurrence is recorded in Sir Wyville Thomson's Depths of the Sea, but I have not seen a specimen.

Other Localities.—This species also occurs off the coast of Greenland, off the eastern coast of North America, off the Scandinavian coast, off Spitzbergen and Nova Zembla, and in the Barents Sea.

Ctenodiscus corniculatus has been found in the fossil state by the late M. Sars [1] in the older beds of the Postpliocene or Glacial formation of Norway, near Christiania.

2. *Ctenodiscus australis,* Lütken (Pl. XXX. figs. 1–6).

Ctenodiscus australis [2] (Lovén, M.S.), Lütken, 1871, Vidensk. Medd. naturh. Foren. i Kjøbenhavn, p. 238.

Localities.—Station 313. Near the Atlantic entrance to the Straits of Magellan. January 20, 1876. Lat. 52° 20′ 0″ S., long. 67° 39′ 0″ W. Depth 55 fathoms. Sand. Bottom temperature 47°·8 Fahr.; surface temperature 48°·2 Fahr.

Station 320. South of Monte Video, off the mouth of the Rio de la Plata. February 14, 1876. Lat. 37° 17′ 0″ S., long. 53° 52′ 0″ W. Depth 600 fathoms. Green sand. Bottom temperature 37°·2 Fahr.; surface temperature 67°·5 Fahr.

Remarks.—This species is readily distinguished by the large paxillæ, by the hidden madreporite, and by the shorter but still well-defined rays, which are obtuse and rounded at the extremity, with large supero-marginal plates there in comparison to those in the other species. The margins of the disk and rays are thick, well-rounded, and tumid, the supero-marginal plates being bevelled slightly towards the abactinal surface. The number of marginal plates is less than in *Ctenodiscus procurator*, and the form altogether is of much smaller habit. The small tubercle or spinelet at the junction of the supero-marginal and infero-marginal plates is more or less aborted.

In the examples from deeper water (Station 320, 600 fathoms) the shortness and the obtuseness of the rays and the prominence of the epiproctal cone or peak in the centre of the abactinal area is especially noticeable.

One specimen from Station 313 (55 fathoms) is remarkable in being regularly four-rayed, with a perfectly cruciform outline. There are four regular mouth-angles, and nothing irregular is noticeable excepting a slight displacement and malformation in a few of the marginal plates near the median interradial line in one interbrachial arc, probably marking the place of the aborted ray. When the starfish is oriented with the madreporiform body in the right anterior interradium, it is the right posterior interradium in which this irregularity occurs; and the position of the displacement of plates appears to indicate that it is the ray No. 5 which is aborted, the ray No. 1 being thus brought into the position of the odd posterior interradium.

[1] Oversigt af Norges Echinodermer, Christiania, 1861, p. 144.

[2] This was a museum-name given by Lovén, and was adopted by Lütken on the understanding that the species was being figured for the descriptive account of the voyage of the "Eugenie." This work has never been completed, and is now discontinued.

3. *Ctenodiscus procurator*, n. sp. (Pl. XXX. figs. 7–12).

This form has so many points of close resemblance to the North-Atlantic *Ctenodiscus corniculatus* that examples might be selected which at first sight would easily be mistaken for that species. A number of small differences, however, present themselves when a large series is examined, which appear sufficiently constant to warrant the recognition of this form as a distinct species. Under these circumstances the description of *Ctenodiscus procurator* will probably be most intelligible if it takes the form of a comparative review of the characters of this species in relation to those of the two previously known species of *Ctenodiscus*, viz., *Ctenodiscus corniculatus* of the North Atlantic, and *Ctenodiscus australis*, Lütken, from the East of Patagonia.

When these three species are compared *inter se* it is evident that in many respects *Ctenodiscus corniculatus*, though so widely separated geographically, appears to occupy an intermediate classificatory position between *Ctenodiscus australis* and *Ctenodiscus procurator*, which inhabit the eastern and western sides respectively of South America. In *Ctenodiscus procurator* the rays are generally a trifle longer, and, even when not actually so, have at least that appearance in consequence of being slightly narrower at the base and more attenuate and pointed outwardly. The abactinal area is plane, its union with the lateral wall, especially in the region of the disk and the base of the rays, forming a sharp angle in consequence of the rapid adoral slope of the whole lateral wall; the supero-marginal plates being also affected in the majority of cases. This feature at once strikes the eye in comparison with the usually vertical and actinally well-rounded margin of *Ctenodiscus corniculatus* and the thick and tumid one of *Ctenodiscus australis*.

The paxillæ of the abactinal area are small and crowded, similar to those in *Ctenodiscus corniculatus*. The madreporiform body is distinct and not hidden by paxillæ as in *Ctenodiscus australis*. The marginal plates appear to be invariably rather more numerous than in *Ctenodiscus corniculatus*, and consequently still more so than in *Ctenodiscus australis*;—for example, in a specimen of *Ctenodiscus procurator*, measuring R = 28·5 mm., there are eighteen supero-marginal plates counting from the median interradial line to the extremity; whereas in *Ctenodiscus corniculatus* of exactly the same radial dimensions (R = 28·5 mm.) there are only fifteen. *Ctenodiscus corniculatus*, with R = 27 mm., has fourteen supero-marginal plates; *Ctenodiscus procurator*, with R = 27 mm., has seventeen. *Ctenodiscus procurator* appears to have generally one or more spines less on the adambulacral plates than in *Ctenodiscus corniculatus*, three only being actually marginal or furrow spines, and a fourth standing backward and on the actinal surface of the plate at the aboral end. Very rarely indeed are four furrow spines present; whereas four and five are general in *Ctenodiscus corniculatus*.

From the foregoing remarks it will be seen that *Ctenodiscus procurator* is much more closely allied to the North-Atlantic *Ctenodiscus corniculatus* than to the comparatively neighbouring form *Ctenodiscus australis*, from which it is readily distinguished. On the

other hand the individual points of difference between the Chilian and the Northern forms are small and trifling, but when taken as a whole may be regarded as sufficient to differentiate them specifically, especially when the constancy of the characters in question and the widely separated geographical position of the two forms are taken into account.

Colour in alcohol, a bleached yellowish white.

Localities.—Station 303. Off the western coast of South America, off the Chonos Archipelago. December 30, 1875. Lat. 45° 31′ 0″ S., long. 78° 9′ 0″ W. Depth 1325 fathoms. Blue mud. Bottom temperature 36°·0 Fahr.; surface temperature 54°·8 Fahr.

Station 306. In the Messier Channel, between Wellington Island and the west coast of Chili. January 2, 1876. Lat. 48° 17′ 0″ S., long. 74° 33′ 0″ W. Depth 565 fathoms. Blue mud. Surface temperature 57°·0 Fahr.

Station 307. Between Wellington Island and the west coast of Chili, off Port Grappler. January 4, 1876. Lat. 49° 24′ 30″ S., long. 74° 23′ 30″ W. Depth 140 fathoms. Blue mud. Surface temperature 53°·0 Fahr.

Station 309. Off Puerto Buono. January 8, 1876. Lat. 50° 56′ 0″ S., long. 74° 15′ 0″ W. Depth 40 fathoms. Blue mud. Bottom temperature 47°·0 Fahr.; surface temperature 50°·5 Fahr.

Station 311. Off the entrance to Smyth Channel. January 11, 1876. Lat. 52° 45′ 30″ S., long. 73° 46′ 0″ W. Depth 245 fathoms. Blue mud. Bottom temperature 46°·0 Fahr.; surface temperature 50°·0 Fahr.

Family Astropectinidæ (Gray, 1840), *emend.*

Several of the forms included in this family have previously been ranked in the genus *Archaster*, as shown in the list of species erroneously referred to that type, given on p. 122. This circumstance may be attributed in a large measure to the great similarity in general facies that exists between many of the Asterids belonging to the two families Archasteridæ and Astropectinidæ, as well as to the want of an exact limitation of the generic scope of *Archaster*.

On the basis of the structural characters indicated in these pages, I consider that the Astropectinidæ are a well-defined family, and that the genera which I have now classed together constitute a natural group distinguished by special morphological features.

Luidia, on account of its structural peculiarities, is in my opinion a very divergent member of the family. The relationship of this genus is in many respects so isolated that I have placed it in a distinct subfamily, in recognition of this fact; and I have associated with it, on structural grounds, the remarkable genus *Platasterias* of Gray, which has latterly been merged in the genus *Astropecten*.

The genus *Ilyaster* of Danielssen and Koren appears to me to belong to this family; and its affinities are probably near to *Phoxaster*.

Synopsis of the Genera included in the Family Astropectinidæ.

A. Adambulacral plates touching the infero-marginal plates along the ray. Marginal and adambulacral plates not correspondent in length and number. Supero-marginal plates more or less well developed. No forficiform pedicellariæ . . . . . Astropectininæ.

a. With a webbed marginal fringe to the marginal plates, and to the actinal intermediate plates . . . . . *Craspidaster.*

b. With no webbed fringe to the marginal plates or the actinal intermediate plates.

a. Supero-marginal plates with a prominent ridge and specially developed fasciolar channels.

α. Actinal interradial areas small, usually with few intermediate plates. Paxillæ with radiating crowns.

i. Marginal plates very short and band-like. Supero-marginal plates much smaller than the infero-marginal plates . . . . . *Leptoptychaster.*

ii. Marginal plates long and more or less quadrate. Superior and inferior series subequal . . . . *Astropecten.*

β. Actinal interradial areas large, with numerous intermediate plates which imbricate and form transverse columns. Paxillæ small, with compact erect crowns and long pedicles . . . . . *Moiraster.*

b. Supero-marginal plates plane, with no ridge and no specially developed fasciolar channels.

α. Spinulation simple, not sacculate. Adambulacral armature forming a straight series on the furrow margin, spinelets numerous and uniform . . . . . *Psilaster.*

β. Spinulation sacculate. Ambulacral armature forming an angulated series on the furrow margin, the spinelets few in number, and the median one of a different shape from the rest.

i. Well-developed epiproctal cone. No pedicellariæ . . . *Phoxaster.*

ii. No epiproctal cone. Sacculated spinelets of the actinal area forming modified pedicellariæ . . . *Bathybiaster.*

B. Infero-marginal plates separated from the adambulacral plates by a small intermediate plate throughout the ray. Marginal and adambulacral plates correspondent in length and number . . . . . Luidiinæ.

a. Supero-marginal plates aborted. Adambulacral plates not separated by a fimbriated channel. Forficiform pedicellariæ present . . . . *Luidia.*

b. Supero-marginal plates present. Adambulacral plates separated by a fimbriated channel. No forficiform pedicellariæ present . . . . *Platasterias.*

Subfamily Astropectininæ, Sladen, 1887.

Genus *Craspidaster*, n. gen.

Archaster (pars), Müller and Troschel, Monatsber. d. k. Akad. d. Wiss. Berlin, 1840, p. 104; System der Asteriden, 1842, p. 65.

Rays five, tapering, subrigid. General form subdepressed and flat.

Supero-marginal and infero-marginal plates largely developed, remarkably thick and

massive. Covered with hyaline, deciduous granules; devoid of spines, excepting one adpressed, flattened, lateral spine on the infero-marginal plates. Deep, well-defined channels along the sutures between successive plates, the margins bordered with a webbed fringe formed of small spinelets enveloped in a continuous membranous investment; the fringe continuous round the inner end of the supero-marginal plates.

Abactinal area with paxillæ. Paxillæ with very massive basement plates, suboval internally, pedicle columnar, crown with one or more central granules on the tabulum, surrounded by a marginal series of short spinelets, which radiate horizontally, and are united, at least in part, by a membranous web.

Adambulacral plates superficially subquadrangular or rhomboid; the furrow margin with a series of short, subcylindrical spinelets, five or six in number, forming a small radiating comb; the other three margins bearing small, skin-covered, papilliform spinelets, directed over a channel which intervenes between adjacent adambulacral plates, and also between the adambulacral and the marginal plates. Actinal area of the adambulacral plates covered with skin and devoid of spines. Ambulacral furrows entirely closed by the adambulacral plates and their armature, when contracted.

Actinal interradial areas well developed, with a few large plates, regular and pavement-like in their disposition, covered with hyaline deciduous granules, each plate margined with a webbed fringe like that on the marginal plates; well-defined channels along the suture lines of the plates.

Superambulacral plates present. Tube-feet conically pointed.

No anus. No pedicellariæ.

Remarks.—The type of this remarkable genus is the starfish to which Müller and Troschel gave the name of *Archaster hesperus*. Specimens, nearly all in a dry state, are to be found in the British Museum, as well as in several of the Continental museums, but the form has nevertheless been left in its anomalous position, although other observers have noted some of its remarkable characters. Under these circumstances I have given below an account in detail of its general structure. It will be seen to have nothing of generic import in common with the two other members of Müller and Troschel's genus *Archaster*, *Archaster typicus* and *Archaster angulatus*, or indeed with the other forms which have been hitherto ranked as *Archaster*. The presence of the superambulacral plates, the conical pointed tube-feet, the absence of an anus, and also the absence of pedicellariæ, would seem naturally to associate this form with the Astropectinidæ, whilst the massive granulose plates, devoid of all spines excepting the lateral, with their singular marginal fringe, the character of the adambulacral plates and their armature, and likewise that of the actinal intermediate plates, constitute a series of structures that isolates the form very distinctly from other genera at present known.

Chorology of the Genus Craspidaster.

α. Geographical distribution:—

Pacific and Eastern Archipelago: One species between the parallels of 0° and 40° N.

Craspidaster hesperus off Japan and China, and in the Eastern Archipelago.

β. Bathymetrical range: Appears to be confined to the Littoral zone: 20 fathoms is the greatest depth recorded.

γ. Nature of the Sea-bottom: Mud.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Craspidaster hesperus . .	{ Pacific and Eastern Archipelago. }	20	Mud.

1. *Craspidaster hesperus*, Müller and Troschel, sp. (Pl. XVII. figs. 5–7; Pl. XVIII. figs. 1–4).

Archaster hesperus, Müller and Troschel, 1840, Monatsber. d. k. Akad. d. Wiss. Berlin, p. 104; System der Asteriden, 1842, p. 65.

Stellaster sulcatus, Möbius, 1859, Neue Seesterne des Hamburger und Kieler Museums, p. 11, Taf. iv. figs. 1 and 2 (Abhandl. a. d. Gebiete Naturw. hrsg. v. d. naturwiss. Verein, Hamburg, Bd. iv. Abth. 2, 1860).

Rays five. R=53 + mm. (the terminal plate being broken off in all the rays of the largest specimen); r=15 mm. Breadth of the ray across the second supero-marginal plates, 14·5 mm.

General form depressed and rigid. Rays moderately long and flat, tapering from the base to the extremity, which is not attenuated or sharply pointed. Interbrachial arcs wide and well rounded. Abactinal surface plane. Actinal surface plane. Margin well rounded; lateral walls highest in the interbrachial arc, decreasing gradually towards the end of the ray.

The abactinal surface of the disk and rays is covered with paxillæ of a rather peculiar form, which I have not observed in any other species. In the immediate centre of the disk the paxillæ are small, crowded, and individually indistinguishable; they also diminish greatly in size as they proceed along the ray, but remain perfectly distinct, and though closely placed throughout, in no way interfere with one another's form by crowd-

ing. The largest paxillæ occur midway between the centre of the disk and the margin, and at the base of the rays. These consist of a comparatively large, convex tabulum, covered with rather coarse hemispherical granules, having more or less of a mulberry form, with a fringe-like series at the margin of the tabulum of short, equal, skin-covered papilliform spinelets, all directed horizontally. On the large paxillæ there may be from ten to twenty granules on the central area of the tabulum, and from sixteen to twenty in the marginal series. In the medium-sized paxillæ, beyond the base of the ray and in the neighbourhood of the margins throughout, there are not more than three or four of the central granules, and eight to ten of the marginal series, whilst in the smaller paxillæ on the outer half of the ray there is seldom more than one central granule, and seven or eight appear to be the normal number of marginal spinelets; in these the membranous investment is even more apparent than on the larger paxillæ, and is continuous or united for a considerable distance between adjacent spinelets. Upon the rays the paxillæ are arranged in remarkably regular, straight, transverse series, which extend uninterruptedly from one series of marginal plates to that on the other side of the ray, traversing the whole paxillar area of the ray. Although there is no formation of a definite median line, the paxillæ in the middle of the area on the inner third of the ray are distinctly larger than the others in the same transverse series.

The marginal plates are large and remarkably massive, forming a broad border to the abactinal and actinal areas, and are well rounded in the lateral wall. The supero-marginal plates, thirty or thirty-one in number from the median interradial line to the extremity, have the breadth equal to about twice the length, the proportion diminishing slightly towards the extremity. Their height at the summit of the interbrachial arc is about twice the length, about midway on the ray it is nearly one and a half, and at the extremity subequal. The width of the paxillar area is equal to that of the supero-marginal plate at the fifteenth plate from the median interradial line; midway on the ray it is rather greater. The plates are slightly, but rather flatly, convex along their median transverse line (*i.e.*, breadth), and are separated by well-defined channels. Their surface is covered with rather large, uniform, tolerably well-spaced, hyaline, hemispherical granules, which are abnormally deciduous, and around the margin of the plate is a fringe of small, uniform, papilliform spinelets, invested with a continuous web-like membrane, directed horizontally in relation to the vertical plane traversing the breadth of the plate; the fringe thus covers over the furrow between the supero-marginal plates, and is continous round the end of the plate abutting on the paxillar area. There are no spines on the supero-marginal plates.

The infero-marginal plates correspond exactly to the superior series, and their length is the same; their height in the lateral view is nearly twice their length at the summit of the interbrachial arc, but diminishes along the ray, being subequal or even slightly less when midway. Their breadth on the actinal surface is about twice the length midway

along the ray, but is considerably greater in the interbrachial arc, where the border formed by the infero-marginal plates occupies very nearly half the space between the mouth-angle and the margin; on the outer part of the ray the proportion of breadth to length diminishes gradually, but the breadth remains preponderant throughout. The surface of the plates is faintly but flatly convex, emphasized by the rounded bevel at the margin of the well-defined transverse channel between each successive plate. The surface of the plates is covered with uniform, well-spaced, hyaline, deciduous, hemispherical granules, similar to, but perhaps slightly smaller than, those on the supero-marginal plates, and the margins are furnished with a similarly webbed fringe of small spinelets directed horizontally over the transverse channels between the plates, the fringe increasing a little in breadth as it approaches the edge of the ray. On the infero-marginal plates which abut against adambulacral plates, the fringe is not present on that edge, but the four innermost infero-marginal plates, that is to say, two on each side of the median interradial line, which abut against the actinal intermediate (ventral) plates, have the fringe continuous round the inner end of the plates, and on a few plates next succeeding a trace of the fringe is discernible, the abortion being effected gradually. Each infero-marginal plate bears a single, small, compressed, comparatively broad, flat, truncate spinelet, scarcely longer than the length of the plate; it is articulated but adpressed to the ray, directed towards the extremity at a slight angle upwards, and it is placed at the extreme margin of the actinal surface, consequently a little below the upper edge of the infero-marginal plate, and stands close to its aboral margin. Occasionally on one or two plates in the interbrachial arc a second smaller and very much narrower spinelet may be present at some distance from the marginal one, on the actinal surface, and likewise close to the aboral margin of the plate.

The adambulacral plates are small, and, as seen with their armature when viewed from above, appear subquadrate or rhomboid in form. Their armature consists of a furrow series of five or six short, cylindrical, slightly tapering spinelets, the outer ones rather smaller than the others, and all radiating slightly apart at an angle over the furrow. The actinal surface of the plate is covered with membrane, and is devoid of spinelets, but bears round its margin, that is to say, on the three remaining sides, a series of small, uniform, skin-covered, papilliform, obtuse spinelets, very much shorter than the furrow series, and directed at an angle of about 45° to the plane of the plate, towards the adjacent plate, whether this be an adambulacral or marginal one. There is thus the appearance of a straight channel intervening between the series of adambulacral plates and the marginal plates over which the series of skin-covered spinelets is directed, and the adambulacral plates are themselves distinctly and clearly spaced. Near the middle of the aboral margin of each adambulacral plate is one comparatively very robust, short, stumpy, subconical spinelet, its posture suggesting resemblance to a thumb in relation to the furrow series of spinelets, if these were considered as the fingers of an outstretched hand.

It is directed at a slight angle to the vertical outwards (sometimes inwards on the outer part of the ray), and towards the extremity.

The mouth-plates are small and elongate, the outline of the united pair being fusiform, and their surface is not convex or prominent actinally. Their armature consists of a marginal series of five or six small spinelets, which extend from the inner extremity to the junction with the adambulacral plate. Close within this series is a second which quite masks them, consisting of a lineal series of eleven or twelve short, robust, subconical and pointed spinelets, which extend from one extremity of the plate to the other, decreasing slightly in length, but less in robustness, as they recede from the mouth.

The actinal interradial areas, which are comparatively small and triangular, are occupied by a few very large, regular, intermediate plates, arranged in definite order, mosaic-like and not imbricating. The first or innermost plate on each side of the median interradial line is considerably larger than the mouth-plates, and the pair together have an hexagonal outline; they occupy fully two-thirds of the distance between the mouth-plates and the marginal plates, and are separated by a median suture corresponding to the median interradial line. The space intervening between this pair and the marginal plates is occupied by a single odd oblong plate standing in the median interradial line; only in one area, in the specimen under description, are there two plates, and these are symmetrical, and the suture marking their line of union falls in the median interradial line. The other plates extend the whole way from the adambulacral to the marginal plates, and vary in shape according to their position. The number also varies from three to five in each half area, and may vary even in the two halves of one and the same area. The second plate counting from within is in all cases the largest plate in the area. The surface of these plates is covered with small, hemispherical, deciduous granules, similar to those on the marginal plates, and round the margin of each plate is a fringe of small spinelets united by a membranous web, similar to that described on the marginal plates, which is directed horizontally over a channel running between the plates.

I have been unable to detect the slightest trace of an anal aperture; indeed, from the small and compact character of the paxillæ in the centre of the dorsal area, it might be said, reasoning from the analogy of *Astropecten*, that no such aperture existed. The region is sometimes slightly protruded in a low cone, sometimes slightly introverted in the centre.

The madreporiform body is moderately large, subcircular, and situated midway between the centre of the disk and the margin. The central area of the body is abruptly elevated and occupied by one of the mulberry-like masses of hemispherical granules similar to those on the tabulum of the paxillæ, and this again is surrounded by the marginal fringe of spinelets (in fact a central, but sessile, paxilla); beneath this the striation-furrows, which are fine, may be seen radiating to the periphery of the body.

The ambulacral furrows are completely closed in by the adambulacral plates and

armature when contracted. The tube-feet have conical tips when extended, but which appear slightly knob-like when contracted.

No pedicellariæ of any kind are present.

Colour in alcohol, a brownish grey over the paxillar area; marginal plates and actinal surface a bleached yellowish white.

Young Phase.—In a small specimen from Station 203, measuring R = 22 mm., $r = 6{\cdot}5$ mm., the number of marginal plates is twenty-four, and in general character this example accords in all points with the adult form, the species being unmistakable. The remarkable webbed fringes are fully developed, and the furrows between the marginal plates are very wide. The number of spinelets in the paxillæ and in the armature of the adambulacral plates is rather less, especially on the attingent sides of the latter, as might naturally be expected. The spinelets in the furrow series range in number from four to six, according to position. On the larger paxillæ of the disk seldom more than six to nine marginal spinelets are present, and not more than one or two central granules; along the ray five or six appears to be the normal number. The madreporiform body is relatively nearer the margin than in the adult form. The centre of the abactinal region is slightly introverted as in many Astropectinidæ. The development of the terminal (or "ocular") plate is interesting. In the young stage referred to, the plate is divided along its entire median line, forming a more or less wide and gaping channel, with the edges rounded, along which the abactinal membrane passes and more or less aborted paxillar spinelets; beneath the membrane lies the terminal tentacle, there being no completion of the calcareous ring on its abactinal side. In the larger example from this locality, a thin, narrow, calcareous connection is developed on the floor of the furrow, but only at the distal extremity of the plate, forming there a delicate arch over the terminal tentacle. This division of the terminal plate is full of significance as regards the formation of this so-called single plate.

Variation.—In the specimen from Station 203 there is a small amount of variation which is worthy of notice, although it might readily be passed over. This occurs in the armature of the adambulacral plates, the prominent robust thumb-like spinelet on the aboral margin of the plate being wanting (see Pl. XVIII. fig. 2). The largest example is smaller than that from Hong Kong, hence it is possible that the "thumb" may be developed only after full maturity is attained. On the other hand it may be said that as the example under notice measures R = $37{\cdot}5$ mm., $r = 9{\cdot}75$ mm., and has exactly the same number of marginal plates (thirty-one, exclusive of the terminal) as the larger Hong-Kong specimen, its normal adult characters may be considered to be present.

On comparing the two forms it may further be remarked that the furrow series of spines on the adambulacral plates are comparatively longer in the specimens from Station 203, and also that the breadth of the adambulacral plates in relation to their length is slightly greater. The marginal spines are comparatively longer and narrower, and they

are frequently pointed and channelled along their length, or gouge-shaped. The spinelets in the webbed fringe on the three attingent sides of the adambulacral plates are fewer in number, as also are the spinelets on the paxillæ of the abactinal area (see Pl. XVIII. fig. 1). These, however, are characters which I regard as attributable to the smaller size.

Localities.—Challenger Expedition:

Hong Kong, 10 fathoms.

Station 203. East of Panay Island (Philippine group). October 31, 1874. Lat. 11° 6′ 0″ N.; long. 123° 9′ 0″ E. Depth 20 fathoms. Mud. Surface temperature 85°·0 Fahr.

Other localities: Japan (Müller and Troschel); Banka Straits (Stockholm Museum); Singapore (von Martens).

Remarks.—Müller and Troschel's type-specimen in Berlin from Japan, collected by Captain Wendt, which I have examined, conforms in all points—in so far as the dry specimen can be compared—with the form above described from Hong Kong. It is, however, somewhat smaller, measuring R = 41 mm., $r = 11{\cdot}5$ mm. The thumb-like spinelet is present in the adambulacral armature. The thumb is also present in a specimen from Banka Straits preserved in the Stockholm collection.

I have likewise seen the type of Möbius's *Stellaster sulcatus*. It is unquestionably the same species. The two specimens are rather small, R = 35 and 36 mm., with $r = 12$ mm., in the example measured by me. This observer has noted[1] the peculiar bordering of spinelets on the marginal and actinal intermediate plates, also the granulate covering of these plates and the general character of the paxillæ.

An example preserved in Copenhagen, which I have also studied, has been carefully described by Lütken,[2] who at the same time pointed out that *Stellaster sulcatus*, Möbius, was synonymous with *Archaster hesperus*.

In the specimen at Leyden, seen by Müller and Troschel, I find that the thumb-like spine on the adambulacral plates is not so largely developed or so prominent as it sometimes is, nevertheless it is present. The locality of this example is unknown; it is simply stated in the System der Asteriden to have been collected by von Siebold.

Genus *Leptoptychaster*, Smith.

Leptychaster, Smith, Ann. and Mag. Nat. Hist., 1876, ser. 4, vol. xvii. p. 110.
Leptoptychaster, Smith, Phil. Trans., Zool. Kerguelen Island, 1879, vol. clxviii. p. 278.

The type of this well-marked genus was obtained off the island of Kerguelen during the sojourn of the British Expedition to observe the transit of Venus in 1875. The collection of Starfishes was described by Mr. E. A. Smith, who clearly diagnosed the present genus; and gave a figure of the species for the reception of which it was established.

[1] Neue Seesterne des Hamburger und Kieler Museums, 1859, p. 11, Taf. iv. figs. 1 and 2 (*Abhandl. a. d Gebiete Naturw. hrsg. v. d. naturwiss. Verein*, Hamburg, Bd. iv. Abth. 2, 1860).

[2] *Videnskab. Medd. naturh. Foren. i Kjøbenhavn*, 1864 (1865), p. 136.

From Mr. Smith's account we learn that the same form had been collected at Kerguelen by the Antarctic Expedition of 1840, but that the species had remained unnoticed and undescribed until worked out by him. Several specimens were obtained by the Challenger Expedition from the same locality.

I have referred to this genus the North-Atlantic form described by Sars under the name of *Astropecten arcticus*, which has since been erroneously relegated to the genus *Archaster*.

Chorology of the Genus Leptoptychaster.

α. Geographical distribution:—

ATLANTIC: One species between the parallels of 35° and 75° N.

Leptoptychaster arcticus off the North Cape, the coast of Norway, and off the eastern coast of North America.

SOUTHERN OCEAN: Two species between the parallels of 40° and 50° S.

Leptoptychaster kerguelenensis off Kerguelen Island and Marion Island. *Leptoptychaster antarcticus* between Marion Island and Kerguelen Island.

β. Bathymetrical range: 10 fathoms to 1350 fathoms.

Greatest range of one species: *Leptoptychaster arcticus*, 20 fathoms to 690 fathoms; and the American variety of the same species, *Leptoptychaster arcticus*, var. *elongata*, extends to 1350 fathoms.

γ. Nature of the Sea-bottom: *Leptoptychaster arcticus* is found, at least in the European area, on clay, sometimes sandy. The American variety, *Leptoptychaster arcticus*, var. *elongata*, occurs on gravel and stones, and an example from 1350 fathoms on blue mud. *Leptoptychaster antarcticus*, on hard ground (gravel, shells). *Leptoptychaster kerguelenensis* on volcanic mud,

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Leptoptychaster arcticus .	Atlantic.	20 to 690[1]	Clay, sometimes sandy.
Leptoptychaster arcticus, var. *elongata*	Atlantic.	85 to 1350	Gravel, stones (85 fathoms). Blue mud (1350 fathoms.)
Leptoptychaster antarcticus .	Southern Ocean.	210	Hard ground (gravel, shells).
Leptoptychaster kerguelenensis	Southern Ocean.	10 to 100	Volcanic mud.

[1] This depth is recorded by Sir Wyville Thomson for *Leptoptychaster arcticus*, west of Ushant (Depths of the Sea), but I have not seen a specimen. Verrill states that this species was dredged by the "Albatross" in 1883 in 547 fathoms (Report of Commissioner of Fish and Fisheries for 1883, Washington, 1885, p. 542).

1. *Leptoptychaster kerguelenensis*, Smith (Pl. XXXI. figs. 1 and 2; Pl. XXXII. figs. 1 and 2).

Leptychaster kerguelenensis, Smith, 1876 (February), Ann. and Mag. Nat. Hist., ser. 4, vol. xvii. p. 110.

Archaster excavatus, Wyville Thomson, 1876 (December), Journ. Linn. Soc. Lond. (Zool.), vol. xiii. p. 71, fig. 10 (woodcut).

Leptoptychaster kerguelenensis, Smith, 1879, Phil. Trans., Zool. Kerguelen Island, vol. clxviii. p. 278, pl. xvii. fig. 2.

Rays five. R = 66 mm.; $r = 13{\cdot}5$ mm. Breadth of a ray near the base (at the fifth infero-marginal plate), 13 mm.

Rays moderately elongate, usually of a depressed subcylindrical form, rather thick at the base, tapering to a somewhat abruptly pointed extremity. Interbrachial arcs wide, with a tendency to become faintly angular. Abactinal area normally subdepressed, but capable of a slight amount of inflation over the disk and also along the rays; when inflated, more or less clearly defined channel-like depressions are formed along the median interradial lines. Actinal surface subplane or slightly convex, passing into the curvature of the margin. Lateral walls rather tumid and well-rounded.

The abactinal surface of the disk and rays is covered with large, closely crowded paxillæ, consisting of six to nine small subclavate spinelets on the area of the tabulum, surrounded by an outer series of similar but more delicate spinelets, and sometimes with a few additional ones at a still lower level, the whole borne on an elongate delicate pedicle. Towards the centre of the disk, along the median line of the rays, and at the extremity, the paxillæ diminish in size, and they are largest in the region of the interbrachial arcs and at the base of the rays.

The supero-marginal plates, which are quite inconspicuous and more or less aborted, bear a paxilla scarcely distinguishable from those on the abactinal surface generally.

The infero-marginal plates are sixty-five to seventy in number, counting from the median interradial line to the extremity. They are very short, measuring little more than 1 mm. in the direction of the axis of the ray, but their transverse dimension is proportionally great, the breadth and height combined being four or five times the length. They are well rounded at the margin which unites the lateral wall and the actinal surface, and form a broad border to the actinal surface in the interbrachial arc and on the inner part of the ray, but which diminishes in breadth on the outer part of the ray, where the posture of the infero-marginal plates becomes more vertical in the lateral wall. A high, narrow, ridge-like keel traverses the median line of a plate, which is covered with a great number of small, robust, uniform, skin-covered, subclavate or papilliform spinelets. The shortest and thickest are on the ridge of the keel, whilst the sides of the intervening channels are crowded with slightly longer, but very much more delicate, cilia-like spinelets.

The adambulacral plates are very small and widely spaced, consecutive plates being

united by broad ligamentous bands. Their armature consists of about seven spines arranged in pairs one behind the other, forming a biserial group transverse to the furrow. The innermost spine advances prominently into the furrow, its base being conformable with the angular projection of the plate, and those of the inner pair or triplet, as the case may be, are slightly longest, the others diminishing as they recede from the furrow. Sometimes on the outer edge of the adambulacral plate there may be a lineal series parallel to the furrow of two or three small papilliform spinelets in addition to the spinelets above noticed, but it is always difficult to distinguish these from the armature of the small intermediate plates, which intervene between the marginal and adambulacral plates along a great part of the ray. It may be remarked that the armature of the adambulacral plates simulates in a most striking manner the character of that occurring in *Cribrella*.

The mouth-plates, which are small and comparatively inconspicuous, form sharply pointed mouth-angles. They bear on their free margin a series of spines similar to, and at the inner end as long as, those on the adambulacral plates, and along the actinal surface of the plate a lineal series of smaller spinelets running parallel to the median suture, all diminishing in length as they recede from the mouth.

The actinal interradial areas, though rather small, are well defined on the actinal area of the disk, and extend as a narrow strip far along each ray; in large examples they may be traced fully along the inner half of the ray and sometimes further. On the actinal area of the disk a row of three or four intermediate plates may be counted between the mouth-plates and the marginal plates on each side of the median interradial line, but these outer series of plates soon disappear. All the plates on the disk-area bear groups of small spinelets, simulating paxillæ, the spinelets being delicate, subclavate, and rather smaller than those on the abactinal paxillæ proper. Along the ray, however, the spinelets on the intermediate plates are almost indistinguishable from the spinelets on the adambulacral plates. In some specimens the spinelets are much more grouped than in others, and when this is the case the plates as indicated by the spinelets appear more distinct and clearly defined.

I have been unable to satisfy myself positively whether this species is proctuchous or not. I have, however, certainly detected the presence of a minute pore in some examples of *Leptoptychaster arcticus*, var. *elongata*, but whether its functions are those of a true anus, I am not at present in a position to say. There is no modification of the paxillæ in the central region of the abactinal surface.

The madreporiform body is hidden from superficial view by paxillæ. In small examples indications of its presence may be detected at about one and a half or two of its own diameters distant from the marginal plates.

The ambulacral tube-feet have a rounded and well-defined terminal knob.

No pedicellariæ of any kind are present.

Colour in alcohol, a bleached yellowish ashy grey, sometimes with a slightly orange or brownish shade.

Variation.—There is considerable variation in the proportions of the length of the ray and the diameter of the disk, and also much difference in the breadth of the rays near the base. The following dimensions may be compared with those of the figured example given above :—

R = 60 mm. ; r = 16 mm. Breadth at fourth or fifth plate, 16 mm. Marion Island.

R = 38 mm. ; r = 11 mm. Breadth at fourth or fifth plate, 11 mm. Marion Island.

R = 36 mm. ; r = 10·25 mm. Breadth at fourth or fifth plate, 8·5 mm. Station 149. Rays cylindrical.

R = 33 mm. ; r = 11 mm. Royal Sound, Kerguelen. Disk large.

R = 13·8 mm. ; r = 5 mm. Marion Island, 50 fathoms. Rays very cylindrical.

As a rule the larger examples are longer in the ray.

Young Phase.—The manner in which the young are carried by the parent in this species after hatching, has already been described by Sir Wyville Thomson[1] in a paper presented to the Linnean Society. The following[2] is the account given by him :—

"The dorsal surface of the body is covered with a tessellated pavement composed of capitate paxilli. The heads of the paxilli in close apposition combine to form a mosaic with rudely hexagonal facets ; and as they are raised upon somewhat slender shafts whose bases, like the plinths of columns, rest upon the soft perisome, arcade-like spaces are left between the skin and the upper calcareous pavement. The eggs pass into these spaces from the ovarial openings : on bending the perisome and separating the facets, they may be seen in numbers among the shafts of the paxilli. There is a continual discharge of ova into the passages, so that eggs and young in different stages of development occupy the spaces at once. The young do not escape until at least six ambulacral suckers are formed on each arm ; they may then be seen pushing their way out by forcing the paxilli to the side, and squeezing through the chink between them. While it is extricating itself, the oral surface of the young is always above ; and the centre of the star with the mouth is usually the part which first protrudes ; then the arms disengage themselves one after another, many of the brood remaining for a time with one or two arms free and the others still under the paxilli. When the young have become disengaged, they remain for a considerable time attached to the parent by the centre of the dorsal surface. I could never satisfy myself by what means this is effected ; the attachment is very slight, and they are removed by the least touch. In this attached stage, until they entirely free themselves, which they do when the number of tentacular feet on each arm has reached about twenty, they cluster in the re-entering angles between the arms of the mother,

[1] *Journ. Linn. Soc. Lond.* (Zool.), 1876, vol. xiii. pp. 55–79.

[2] *Loc. cit.*, pp. 71–73. Also Voyage of the Challenger, The Atlantic, London, 1877, vol. ii. pp. 234–237, where the priority of Smith's name is acknowledged.

spreading a little way along the arms and on the dorsal surface of the disk; the young escape from the marsupium chiefly in the neighbourhood of the angles between the rays."

"We took *Archaster excavatus* only on that one occasion; and the weather was so boisterous at the time that it was impossible to trace the early stages in the development of the embryo. It is evident that the process generally resembles that described by Professor Sars in *Pteraster militaris;* and it is quite possible that, while there is certainly not the least approach to the formation of a locomotive bipinnaria, as in that species some provisional organs may exist [at] an early period."

The specimen upon which these observations were made has been figured in Pl. XXXI., a number of young in different stages of development are admirably preserved *in situ*, and may be seen protruding from amongst the paxillæ in the interbrachial regions. As noticed by Sir Wyville Thomson, it is in all cases the actinal surface which is first presented, and even whilst the young starfish is still resting entirely within the arcade-like spaces amongst the paxillæ and before any protrusion of the rays takes place, this appears to be the normal posture, *i.e.*, the actinal surface uppermost.

From the remarks above quoted it would appear that Sir Wyville Thomson was under the impression that the young were even at this stage actually attached to the parent by the centre of the abactinal surface, although he was unable to satisfy himself by what means this was effected. Like him I have failed to detect any organic or membranous connection, and I am disposed to think that such did not exist. I make the remark, however, with all reserve and caution, for it would obviously be bold to dogmatise on the former existence of such a delicate connection, of which no trace remains after the specimen has been preserved in spirits for so long a time. I may further remark that not the slightest trace of any extension or projection of any of the larval tissues can be detected on the dorsum of a young individual of about 3 mm. in diameter, which I have reduced to serial sections. The paxillæ of the abactinal surface are fully formed, and the epidermal or dorsal membrane, which covers the plates from which the paxillæ spring, is continuous. The mouth also is fully formed, and the œsophageal portion of the alimentary tract is capable of considerable protrusion.

The form of the young individual is remarkable. The height is nearly as great as the total diameter; the abactinal surface forms a subplane area excepting the slight rounding or convexity along the median radial lines, whilst the actinal surface is prominently convex, with the mouth at the summit of the curvature, which slopes thence at a rapid angle of declivity to the extremity of the rays.

The largest young one carried by the starfish under notice measures about $R = 3{\cdot}5$ mm., and has ten or eleven pairs of tube-feet in each ray. There are four or five spinelets on each adambulacral plate, one prominent into the furrow, the others forming oblique pairs behind it, though some may stand singly. The transverse disposition of the groups

upon the plates is already clearly presented. The terminal knobs of the tube-feet are large and well-developed. I have not been able to detect an anal pore.

The smallest young one which has protruded itself sufficiently to be measured is about R = 1·5 mm. Larvæ of different stages of growth are still to be seen protruding in each interbrachial arc, as many as seven in one case, and from the appearance of the paxillæ several have probably dropped off since death.

I have succeeded in finding young forms beneath the paxillæ in other examples of *Leptoptychaster kerguelenensis* besides the one mentioned by Sir Wyville Thomson, but in no case so conspicuously as in this.

Localities.—Station 149E. Off Cape Maclear, on the south-east coast of Kerguelen. January 21, 1874. Lat. 49° 37′ 0″ S.; long. 70° 16′ 0″ E. Depth 30 fathoms.

Stations 149B and D Royal Sound, Kerguelen. Depth 25 and 28 fathoms.

Betsy Cove, Kerguelen. Depth 15 to 25 fathoms.

Other stations off Kerguelen in depths of 10 to 50 and 100 fathoms.

Off Marion Island. Depth 50 fathoms.

The bottom deposit at all the Stations in the neighbourhood of Kerguelen is a greenish volcanic mud.

Remarks.—This species is readily distinguished both from *Leptoptychaster arcticus* and *Leptoptychaster antarcticus* by the smaller disk and the longer rays, which are more subcylindrical in character, by the smaller actinal interradial areas, by the larger abactinal paxillæ, and by the peculiar arrangement of the adambulacral armature simulating that of *Cribrella*.

From the remark made by Sir Wyville Thomson, when first recording this species under the name of *Archaster excavatus*,[1] wherein he states that it is not far removed from *Archaster andromeda* (now named *Psilaster andromeda*) of the Northern Seas, it would appear probable that he was confounding along with the present species *Bathybiaster loripes* which was also taken, and in more considerable numbers than *Leptoptychaster kerguelenensis*, at Kerguelen. At first sight I was myself tempted to fall into the same error. On closer examination, however, the two forms are found to be widely different. *Bathybiaster* is readily distinguished by the well-developed supero-marginal plates, by the peculiar sacculate character of the whole actinal spinulation, by the incipient pedicellariæ, and by the totally different form and disposition of the adambulacral armature. The mouth-plate armature is different, and the general form of *Bathybiaster* is likewise different.

The figure given by Mr Edgar A. Smith[2] does not appear to me to be a particularly happy representation of the facies of this species; but his type was probably not in a good state of preservation.

[1] *Journ. Linn. Soc. Lond.* (Zool.) 1876, vol. xvii. p. 71.

[2] *Phil. Trans.*, Zool. Kerguelen Island, 1879, vol. clxviii. pl. xvii. fig. 2.

2. *Leptoptychaster arcticus*, Sars, sp.

Astropecten arcticus, Sars, 1851, Reise i Lofoten og Finmarken, Nyt Mag. f. Naturvidensk., Bd. vi. p. 161; Fauna Litt. Norvegiæ, 1856, Heft 2, p. 61, pl. ix. figs. 16–18; Oversigt af Norges Echinodermer, 1861, p. 32.

Astropecten Lütkeni, Barrett, 1857, Ann. and Mag. Nat. Hist., ser. 2, vol. xx. p. 46, pl. iv. fig. 3, *a*, *b*, *c*.

Archaster arcticus, Perrier, 1878, Nouv. Archives Mus. Hist. Nat., 2e Sér., t. i. pp. 32, 88. (Also Verrill, and Storm).

Localities.—"Porcupine" Expedition:

Station 65 (1869). Between the Shetland and the Faeröe Islands. Lat. 61° 10′ N., long. 2° 21′ W. Depth 345 fathoms. Bottom temperature – 1°·1 C.; surface temperature, 11°·1 C.

Station 82 (1869). In the Faeröe Channel. Lat. 60° 0′ N., long. 5° 13′ W. Depth 312 fathoms. Bottom temperature 5°·2 C.; surface temperature 11°·2 C.

Station 3 (1870).[1] West of Ushant. Lat. 48° 31′ N., long. 10° 3′ W. Depth 690 fathoms.

Remarks.—This form was originally described as an *Astropecten*. Some subsequent writers have retained it in that genus, whilst others have regarded it as an *Archaster*. I am unable to agree with either of these determinations. After careful study I consider that its structure accords in all points of generic import with the genus *Leptoptychaster* established by Mr Smith for the foregoing form from the Southern Ocean, and I have therefore referred the species under notice to that genus. It is readily characterised by the aborted supero-marginal plates, the short but broad infero-marginals (both alike unarmed), the well-developed actinal interradial areas, the character of the paxillæ, and likewise that of the armature of the adambulacral plates. Finally, the species has more or less well-developed superambulacral plates; the whole forming a combination of characters which accords neither with *Archaster* nor *Astropecten*.

2*a*. *Leptoptychaster arcticus*, var. *elongata*, nov.

The American examples of this species, of which a large series was taken at Station 49, are all distinctly longer in the ray, and have the paxillæ of the abactinal area somewhat more delicate and less compact in character than in the European forms, although even in these some variation occurs. It would, however, be an easy matter to say which were the American examples out of a large number of mixed specimens, and on these grounds I consider that we are dealing with a well-marked variety.

Localities.—Station 46. Off the coast of North America, east of New Jersey and Long Island. May 6, 1873. Lat. 40° 17′ 0″ N., long. 66° 48′ 0″ W. Depth 1350 fathoms. Blue mud. Bottom temperature 37°·2 Fahr.; surface temperature 40°·0 Fahr.

[1] Recorded by Sir Wyville Thomson in The Depths of the Sea; but I have not seen a specimen from this locality.

Station 49. South of Halifax, Nova Scotia. May 20, 1873. Lat. 43° 3′ 0″ N., long. 63° 39′ 0″ W. Depth 85 fathoms. Gravel, stones. Bottom temperature 35°·0 Fahr.; surface temperature 40°·5 Fahr.

3. *Leptoptychaster antarcticus*, n. sp. (Pl. XXXI. figs. 3 and 4; Pl. XXXII. figs. 7 and 8).

Rays five. R = 15 mm., r = 6 mm. R = 2·5 r. Breadth of a ray between the fourth and fifth marginal plates, 5 mm.

Disk large and inflated; rays short, broad at the base and thence tapering gradually to a sharply pointed extremity. Interbrachial arcs wide and subparaboloid in outline. Abactinal surface of the disk convex and subject to more or less inflation; that of the rays subcarinate, with the character strongly marked at the extremity, but towards the disk gradually merging into the general tumidity, the inflation being sometimes emphasised in spirit specimens by the presence of a slight depression along the median interradial line, probably consequent on the posture of the rays at death. Actinal surface plane. Lateral margin thin and rounded.

The abactinal surface of the disk and rays is covered with very small and rather widely spaced paxillæ, consisting of twelve to fifteen or more extremely fine, short, delicate spinelets disposed in a little tuft, but radiating more or less apart. No definite order of arrangement is discernible in the paxillæ.

The marginal plates are small and short. The superior series are very small; and have the appearance of being enlarged paxillæ rather than true marginal plates. They are confined entirely to the margin and the abactinal side; and not infrequently the edge of the infero-marginal plates is also just visible when the animal is viewed from above. They bear a tuft of spinelets similar to, but slightly larger than, those on the true paxillæ, and these are arranged on a well-developed eminence. They are devoid of any large spines whatever.

The infero-marginal plates are twenty-one in number, counting from the median interradial line to the extremity, and their breadth on the inner part of the ray is four or five times the length or even more, but diminishes as they proceed along the ray. They are well rounded at the margin and form a broad border to the actinal surface; their posture being very oblique in relation to the median radial line. Along the median line of each plate, that is to say, traversing its greatest dimension, is a high, narrow keel, which bears a covering of small, delicate, uniform spinelets, slightly larger than those on the supero-marginal plates and abactinal paxillæ; these are directed outwards and over the intervening channels between the keels.

The adambulacral plates are small, with the length and breadth nearly equal. They bear an armature closely resembling that found in some species of *Astropecten*, which con-

sists of a marginal series of three delicate, rather long, subequal spinelets, the margin of the plate forming a slightly angular projection into the furrow, and the middle spine is placed on the summit of the angle. External to these on the surface of the plate are usually two (sometimes three) subequal and rather shorter spines, which may form with the adoral spinelet of the marginal series an obliquely transverse lineal series, or may stand directly behind each of the outside spinelets; and behind these is a third series of about three short spinelets parallel to the furrow. The second and third series are not, however, always regular in their number and posture, and additional spinelets may be present; furthermore, the whole of these spines are so closely placed that the armature has generally more or less of a tufted or grouped appearance, which makes it usually difficult to define the true order of their disposition.

The mouth-plates are elongate and narrow. Their armature consists of a marginal series of twelve to fifteen small spinelets similar and equal in length to, but slightly more robust than, the spinelets of the adambulacral armature, on the inner part of the plate, but diminishing slightly as they recede from the mouth. On the actinal surface of the plate is a lineal series of uniform spinelets running parallel to the median suture.

The actinal interradial areas are large and extend nearly half-way along the ray, that is, as far as the ninth or tenth free adambulacral plate. They are occupied by intermediate plates bearing large well-defined, well-spaced paxillæ, which form transverse series between the adambulacral and marginal plates. The paxillæ are composed of delicate, rather elongate spinelets, a little smaller than those borne on the adambulacral plates but larger than those on the infero-marginal plates. The spinelets radiate at an angle of about 45° or more to the perpendicular and form an expanded crown. The column or pedicle of the paxillæ is not cylindrical but more or less flattened and elongate in the direction obliquely transverse to the median line of the ray.

There is no modification in the central region of the disk, and I have been unable to detect the presence of an anal aperture. In one example there is, at a considerable distance from the centre, what seems to me a deceptive appearance of a pore, but from its position and character I do not consider it to be an anal orifice. Even if it should ultimately prove to be a pore, I should not suspect from its general appearance that its function was anal. It may perhaps be a malformed or altered papular orifice, or it may be accidental.

The madreporiform body is small and placed near the margin, being less than its own diameter distant from the supero-marginal plates. In smaller specimens it appears to be rather further away. The striations are comparatively coarse, and several radiate as straight lines from the centre to the margin of the body, the intermediate striation being likewise often straight and short, resembling to a certain degree the septa of a coral.

The ambulacral tube-feet, though tapering, have a small rounded terminal knob.

I have failed to detect any pedicellariæ whatever.

Colour in alcohol, a dirty ashy or brownish grey.

Locality.—Station 148. Between Marion Island and Kerguelen Island. January 3, 1874. Lat. 46° 47′ 0″ S., long. 51° 37′ 0″ E. Depth 210 fathoms. Hard ground (gravel, shells). Surface temperature 41°·0 Fahr.

Remarks.—This form is unquestionably the southern representative of *Leptoptychaster arcticus*, Sars, sp., of the North Atlantic, to which it is structurally nearly related. It is distinguished by the comparatively larger disk and shorter rays, the latter being also broader at the base and more sharply pointed at the extremity. The superomarginal plates are relatively smaller or more aborted, the paxillæ of the abactinal area are smaller and less compact, and the adambulacral armature is usually more compact and grouped in its disposition. *Leptoptychaster kerguelenensis*, Smith, is distinguished by the longer and more cylindrically rounded rays, by the larger and more compact paxillæ of the abactinal surface, by the smaller actinal interradial areas, and, above all, by the characteristic adambulacral armature, almost recalling that of *Cribrella* in its character.

It is interesting to note that *Leptoptychaster antarcticus* is more nearly related to the distant Arctic form than to the comparatively neighbouring species *Leptoptychaster kerguelenensis;* perhaps a more extended series of specimens than we possess at present might lead to *Leptoptychaster antarcticus* being ranked as a variety only of the northern form. At present I do not feel justified in taking that step.

Genus *Moiraster*, n. gen.

Disk large. Rays rather elongate, broad at the base and tapering to the extremity.

Marginal plates of both series with well-developed ridges, separated by deep fasciolar channels. Infero-marginal plates with large flattened spatulate spinelets, chisel-shaped or square-cut at the tip. No prominent large spines on either series.

Abactinal area with paxillæ borne on stellate plates, without internal imbricating ridges. Paxillæ with long pedicles, and erect compact crowns of short inbending spinelets. No definite medio-radial series.

Actinal interradial areas large, with numerous intermediate plates arranged in regular transverse columns, each plate imbricating on its neighbour in its own column. The intermediate plates extend along fully two-thirds of the ray, and all bear stout, flattened, spatulate spinelets.

Armature of the adambulacral plates more or less regularly triserial, simulating that of *Astropecten*. A series of usually three spines form a triangle on the furrow margin, and are followed by two outer series of two or three stout chisel-shaped spines, similar to those on the actinal intermediate plates.

Strongly developed superambulacral plates are present.

Madreporiform body large, a little more than its own diameter distant from the margin.

Remarks.—The genus *Moiraster* is established for the reception of a well-characterised form described by Professor Jeffrey Bell[1] under the name of *Archaster magnificus*, the types of which are in the British Museum.

Through the kindness of Professor Bell I have had every facility for examining this interesting starfish. Judging from the superficial examination of the dried examples I consider that the character of the abactinal plating, the form of the marginal plates, the extensive development of the interradial areas, the character of the intermediate plates, and the presence of the strongly-developed superambulacral plates of *Archaster magnificus* necessitate its separation from *Archaster* as now defined. I have also great doubts as to the presence of an anal orifice. I regard the form as the type of a distinct genus, for which, at the request of my friend, I have proposed a name, in order that it might be placed in the foregoing synopsis. The natural position of *Moiraster* appears to be intermediate between *Leptoptychaster* and *Astropecten*.

Supplementary to the excellent specific description given by Professor Bell, I have added the preceding notes on the characters which may be taken as diagnostic of the genus.

1. *Moiraster magnificus*, Bell, sp.

Archaster magnificus, Bell, 1881, Ann. and Mag. Nat. Hist., ser. 5, vol. viii. p. 440.

Locality.—St Helena. Collected by Mr J. C. Melliss.

No example of this form was obtained by the Challenger Expedition.

Genus *Astropecten*, Linck.

Astropecten, Linck, De Stellis marinis, 1733, p. 26.
Stellaria, Nardo, De Asteriis, Oken's Isis, 1834, p. 716.
Asterias, Agassiz, Mém. Soc. Sci. Nat. Neuchatel, 1835, t. i. p. 168.
Crenaster, d'Orbigny, Prodrome de Paléontologie, 1850, t. i. p. 240.

This genus is world-wide in its distribution, but confined to the temperate and tropical regions. Nearly all the species inhabit shallow water, and, with the exception of three, are confined to the Littoral zone.

The number of species is large, and the morphological plasticity of the genus considerable, as might naturally be expected in a type extended over such a wide area; the species maintaining, however, the type facies in a remarkable manner.

[1] *Ann. and Mag. Nat. Hist.*, 1881, ser. 5, vol. viii. p. 440.

The general distribution of all the recognised species of which the locality is known is given under the section on the chorology of the genus.

A number of forms which are structurally different have been at various times referred to the genus *Astropecten*, but it is unnecessary to recapitulate here the list of the erroneous references corrected by previous workers. The grounds for the removal of those forms with which the present Report is concerned will be found discussed in their proper place.

The following scheme will assist in showing the relative characters of the species obtained by the Challenger Expedition.

Synopsis of the Species included in the Genus Astropecten *herein described.*

A. With two series of definite spines on the supero-marginal plates.
  a. Three lateral spines. Adambulacral armature with three spines in the furrow series, and three also in the second series, the aboral largest . . . . *brasiliensis.*
  b. One lateral spine. Adambulacral armature with four or five spines in the furrow series; the actinal surface of the plate occupied by a group of papilliform and equal-sized spinelets . . . . . *brevispinus.*

B. With one series of definite spines on the supero-marginal plates.
  a. With large, prominent spines on the supero-marginal plates.
    a. With large, well-developed spines on the infero-marginal plates. No naked spaces . . . . . *polyacanthus.*
  b. With small spines on the supero-marginal plates.
    a. The series of supero-marginal spines continuous throughout the ray.
      α. Lateral spines four, in an oblique comb. Adambulacral armature in three series, with three spines in each . *pectinatus.*
      β. One lateral spine, long and cylindrical, with two small companions close behind. Adambulacral armature with the spines of the second and third series frequently grouped, normally three in each. A spine on the infero-marginal plate near the adambulacral plates . *acanthifer.*
    b. The series of supero-marginal spines not continuous throughout the ray.
      α. Wanting in the interbrachial arc.
        i. One lateral spine. Adambulacral armature in three series . . . . . *japonicus.*
      β. Wanting on the outer half of the ray, but continuous in the interbrachial arc.
        i. Three lateral spines. Adambulacral armature in two series . . . . . *imbellis.*

C. With only an indefinite spinelet, or several enlarged granules, on the supero-marginal plates.
  a. One lateral spine.
    a. Adambulacral armature with usually two spines in the second series, very broad and flaring. No aboral line of spinelets on the infero-marginal plates. Actinal spinulation chisel-shaped and truncate. Lateral spines much flattened . . . . . *hermatophilus.*

b. Adambulacral armature with three spines in the second series. With an aboral line of spinelets on the infero-marginal plates. Actinal spinulation spatulate, obtusely rounded or pointed. Lateral spines cylindrical or slightly flattened . . . . *irregularis.*

b. Four or five lateral spines in diagonal line. Outer spines of the adambulacral armature short, not broad nor flaring, placed diagonally. An aboral line of spinelets on the infero-marginal plates . . . . . *pontoporæus.*

D. With no spinelets on the supero-marginal plates, excepting in some species a very small one on the first or first four or five plates in the interbrachial arc.

a. With small spinelets on the first four or five plates.

a. With four or five spinelets. A well-developed series of pseudo-pedicellariæ . . . . . *zebra.*

b. With one spine only, on the first plate. No pedicellariæ . . . *velitaris.*

b. With no spines whatever on the supero-marginal plates.

a. One lateral spine.

α. With two or three spines in the second series of the adambulacral armature.

i. Supero-marginal plates broad, with small granules. Paxillæ with five to eight granules (or spinelets) on the central tabulum . . . . *granulatus*

ii. Supero-marginal plates narrow, with large granules. Paxillæ with one granule on the central tabulum . . . . . *monacanthus.*

b. Lateral spines two, side by side. Infero-marginal plates covered with squamules. An aboral line of spinelets present. Lateral spines taper and pointed. Supero-marginal plates very broad . *cingulatus.*

c. Lateral spines four, in an oblique line. Spines of the adambulacral armature all cylindrical and taper. Infero-marginal plates with papilliform spinelets rather than squamules. No aboral line of spinelets. Supero-marginal plates not very broad . . . *mesactus.*

Chorology of the Genus Astropecten.

a. Geographical distribution :—

Atlantic : Twenty-two species between the parallels of 70° N. and 40° S.

On the eastern side : *Astropecten irregularis,* off the coasts of Scandinavia and Britain; and in the Mediterranean (*fide* Marion). *Astropecten serratus,* off the west coast of France (this species is also reputed to be a Mediterranean form, but its claim to be so considered appears to be doubtful). *Astropecten aurantiacus, Astropecten bispinosus, Astropecten jonstoni* (= *Astropecten squamatus,* M. and T.), *Astropecten pentacanthus, Astropecten platyacanthus,* and *Astropecten spinulosus,* in the Mediterranean. *Astropecten aurantiacus* also extends to the Canary Islands. **Astropecten hermatophilus,* off the

Azores. *Astropecten schœnleinii*, off the west coast of Africa. **Astropecten mesactus*, off Tristan da Cunha. *Astropecten capensis* and *Astropecten pontoporæus*, off the Cape of Good Hope.

On the western side: *Astropecten vestita*, off the eastern coast of the United States. *Astropecten articulatus*, from New Jersey to the West Indies (*fide* A. Agassiz). *Astropecten alligator* and *Astropecten duplicatus*, off Florida, the latter extending to Mexico, the Antilles, and Brazil. *Astropecten ciliatus*, off the coast of Venezuela. *Astropecten richardi*, off French Guiana. *Astropecten antillensis* and **Astropecten brasiliensis*, off the Antilles, the latter extending to Brazil, as far south as Rio de Janeiro. **Astropecten cingulatus*, off the coast of Brazil, south-east of Pernambuco.

Indian and Southern Oceans: Six species between the parallels of 30° N. and 40° S.

Astropecten hemprichii and *Astropecten polyacanthus*, in the Red Sea and off Mauritius, the latter species extending to Ceylon, Japan, Admiralty Islands, Australia, and New Zealand. *Astropecten mauritianus*, from Mauritius. *Astropecten petalodea* (= *Astropecten euryacanthus*, Ltk.), from the Nicobar Islands. *Astropecten preissii* and *Astropecten triseriatus*, off South-West Australia.

Eastern Archipelago: Eight species between the parallels of 20° N. and 20° S.

Astropecten javanicus and *Astropecten longispinus*, from Java. **Astropecten imbellis* and **Astropecten monacanthus*, off the Philippine Islands. **Astropecten zebra*, from Torres Strait. **Astropecten acanthifer*, in the Banda Sea. **Astropecten granulatus*, in the Arafura Sea. **Astropecten velitaris*, off Amboina, and extending to the Admiralty Islands and China.

Pacific: Thirteen species between the parallels of 40° N. and 40° S.

On the western side: **Astropecten brevispinus*, **Astropecten japonicus*, *Astropecten scoparius*, *Astropecten formosus*, and **Astropecten polyacanthus*, from Japan, the last species extending to China, the Fiji Islands, Admiralty Islands, Australia, and New Zealand. *Astropecten velitaris*, off China, and extending to Amboina and the Admiralty Islands. *Astropecten samoensis*, off the island of Samoa. **Astropecten pectinatus*, off the south-east coast of Australia. *Astropecten edwardsi*, off New Zealand.

On the eastern side: *Astropecten regalis*, extending from Mexico

nearly to Panama. *Astropecten erinaceus*, from California to Peru. *Astropecten fragilis*, from Panama to Peru. *Astropecten peruvianus*, off Peru.

The species dredged during the Challenger Expedition are marked in the foregoing list with an asterisk.

β. *Bathymetrical range:* Shallow water to 450 fathoms.

The majority of the species are confined to the Littoral zone; and none extend into the Abyssal zone. Only three forms are found in the Continental zone (*i.e.*, in depths between 150 and 450 to 500 fathoms), viz., *Astropecten brevispinus* in 345 fathoms, *Astropecten hermatophilus* in 450 fathoms, and *Astropecten irregularis* in 375 fathoms.

Greatest range of one species: *Astropecten irregularis*, from shallow water to 375 fathoms.

γ. *Nature of the Sea-bottom:* Exact particulars of the nature of the habitat of the Littoral species are available in very few instances. Of the forms obtained by the Challenger, *Astropecten acanthifer* and *Astropecten japonicus* were found on Blue mud, the latter also on sand. *Astropecten brevispinus*, *Astropecten granulatus*, and *Astropecten imbellis* were found on Green mud, in depths between 28 fathoms and 345 fathoms. *Astropecten cingulatus* lives on Red mud. *Astropecten hermatophilus* on Volcanic mud in 450 fathoms; the greatest depth at which *Astropecten* has been found.

The localities of the following species are unknown, and their names have consequently not been included in the foregoing list:—

Astropecten alatus, Perrier.
Astropecten arenarius (Val.), Perrier.
Astropecten buschii, Müller and Troschel.
Astropecten calcitrapa, Lamarck, sp.
Astropecten dussumieri, Perrier.
Astropecten hispidus, Müller and Troschel.
Astropecten tiedemanni, Müller and Troschel.

The types of the following species appear to be lost, and as it is in my opinion impossible to identify them, I consider that the names should in future be discarded. To endeavour to recognise them is simply an exercise of the imagination.

Astropecten diplacanthus, Grube.
Astropecten echinatus major, Linck.
Astropecten echinatus minor, Linck.
Astropecten fimbriatus, Linck.
Astropecten gracilis, Gray.
Astropecten mesodiscus, Linck.
Astropecten olfersii, Grube.
Astropecten regularis, Linck.
Astropecten stellatus, Linck.

Chorological Synopsis of the Species herein described.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Astropecten acanthifer	Eastern Archipelago.	140	Blue mud.
Astropecten brasiliensis	Atlantic.	7 to 20	Shallow water.
Astropecten brevispinus	Pacific.	345	Green mud.
Astropecten cingulatus	Atlantic.	32 to 400[1]	Red mud.
Astropecten granulatus	Eastern Archipelago.	28	Green mud.
Astropecten hermatophilus	Atlantic.	450	Volcanic mud.
Astropecten imbellis	Eastern Archipelago.	100	Green mud.
Astropecten irregularis	Atlantic.	64 to 374	.....
Astropecten japonicus	Pacific.	5 to 50	Sand. Blue mud, 15 fathoms.
Astropecten mesactus	Atlantic.	90	.....
Astropecten monacanthus	Eastern Archipelago.	20	Mud.
Astropecten pectinatus	Pacific.	6 to 40	Sand and shells.
Astropecten polyacanthus	Pacific.	2 to 50	.....
Astropecten pontoporæus	Atlantic.	5 to 20	Shallow water.
Astropecten velitaris	Eastern Archipelago.	15 to 25	.....
Astropecten zebra	Eastern Archipelago.	8	Coral mud.
Astropecten zebra, var. *rosea*	Eastern Archipelago.	6	Coral mud.

1. *Astropecten brasiliensis*, Müller and Troschel.

Astropecten brasiliensis, Müller and Troschel, 1842, System der Asteriden, p. 68.

Localities.—Off Bahia. Depth 7 to 20 fathoms.

Off Fernando Noronha. Shallow water.

Remarks.—The examples from Fernando Noronha, when compared with similar-sized specimens from Bahia, have the supero-marginal plates comparatively narrower, and the rays also are proportionally rather narrower. In the armature of the adambulacral plates the spinelets on the actinal surface of the plates immediately behind the furrow series have often the appearance of forming a triple series, in consequence of the prominence of the small lateral spinelets which accompany the large spine. These specimens have a very prominent and well-defined conical eminence in the central region of the disk.

2. *Astropecten brevispinus*, Sladen (Pl. XXXIII. figs. 1 and 2; Pl. XXXVII. figs. 1–3).

Astropecten brevispinus, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 249.

Rays five. $R = 32$ mm.; $r = 10$ mm. $R > 3\,r$. Breadth of a ray at the base, about 11 mm.

Rays tapering regularly from the base to the tip, and terminating in a point. Interbrachial arcs slightly rounded.

[1] The exact station and depth at which this form was dredged are not recorded.

The paxillæ of the abactinal area are small and compact, and composed of six to nine spinelets, of which one is central. The spinelets, which are short and robust, are directed upward, and their radiation apart is very slight. No definite order is maintained in the arrangement of the paxillæ. The papulæ are small, and dark brown or almost black in colour; and a broad space occurs along the median line of the ray in which none are present. In the centre of the disk there is a large and conspicuous conical prominence, upon and in the neighbourhood of which the paxillæ are greatly reduced in size.

The supero-marginal plates, which are twenty-two in number from the median interradial line to the extremity, are higher than broad along the inner half of the ray, but broader than high on the outer portion. Each plate, excepting two or three in the interbrachial arc and a few at the extremity, bears two small, conical, sharply pointed spines. The inner series are placed close to the inner edge of the plates, and are continuous from the arm-angle until near the tip, decreasing in size as they proceed outward, until they disappear altogether. The outer series are slightly larger, and are placed at the extreme edge of the plates on the curvature where the abactinal and lateral superficies unite; they are continuous throughout the ray, excepting the innermost plate on each side the median interradial line.

The infero-marginal plates are higher than broad, and flush with the superior series. Each plate bears a single lateral spine, which is short, tapering continuously from base to tip, sharply pointed and slightly compressed. On the inner half of the ray, two similar and slightly smaller spines are situated on the median line of the plate—one, which is the smallest, not far from the inner edge of the plate adjoining the adambulacral plates, and the other about midway between this spine and the lateral spine, the three forming a lineal series transverse in relation to the direction of the ray. On the outer portion of the ray the inner spine is aborted or indistinguishable from the squamules of the plate. When the side or lateral wall of the ray is placed in direct view, the above-mentioned spines of the infero-marginal plates are all visible, and they, together with the spinelets of the supero-marginal plates, appear to form a continuous vertical series. The lateral spine is very little, if at all, longer than the outer spine on the supero-marginal plate, and all these spines stand at an angle to the superficies of the plate, and are directed upward and outward. Very short, widely spaced, papilliform squamules are distributed over the surface of the infero-marginal plates, and the granulation of the supero-marginal series partakes of the same character, and is indistinguishable at the junction of the plates.

The armature of the adambulacral plates consists of short, robust, subpapilliform spinelets, which do not taper, and stand more or less perpendicular to the surface of the plate. The furrow series consists of four or five spines, and their base line forms a slight angle projecting into the furrow; the middle spinelets are a shade larger and more robust than the others. The actinal surface of the plate behind the furrow series is occupied by spinelets which are little more than elongate papillæ; they are small, stumpy, covered

with membrane, rather widely spaced, and usually no definite order of arrangement is discernible, although about two irregular rows may be traced in some instances.

The spinelets on the actinal intermediate plates are similar in character and disposition to the foregoing, and they merge imperceptibly into the squamules of the infero-marginal plates. This uniformity in the dermal appendages imparts a characteristic appearance to the actinal aspect of the starfish.

The mouth-plates are elongate, each with two short, flattened, truncate spinelets at the inner extremity, followed by about six pairs of short robust spinelets, which stand perpendicular on the surface of the plate, and form two series apposed to one another; these are succeeded by about four rather broader, shorter, and more robust spinelets, forming a single series in continuation, as it were, of the two apposed series, on the outer extremity of the plate, towards which the spinelets decrease as they proceed outward. Consequent on this method of arrangement there is a marked division of the mouth-plate armature into two narrow series separated by the median suture line of each mouth-angle.

The madreporiform body is small, and situated at about one-third of the distance from the margin to the centre of the disk.

The terminal (ocular) plate, though small, is conspicuous and elongately oblong.

Colour in alcohol, umber-brown, becoming lighter in shade towards the extremities of the rays. The spinelets are white. Small specimens are yellowish white.

Young Phase.—A small example, which has a major radial measurement of 16·5 mm., may readily be distinguished as belonging to the species. It is to be noted, however, that the paxillæ of the abactinal area have quite a different character, the spinelets of the crown being long, and radiating nearly horizontally. The armature of the adambulacral plates and mouth-plates is comparatively longer, especially on the latter; and on the actinal surface of the adambulacral plates behind the furrow series there are usually one or two larger spinelets, thickly invested with membrane, especially noticeable on the inner part of the ray, but of which no trace remains in the adult—that is to say, their prominence and juvenile robustness are altogether lost.

Locality.—Station 232. Off the coast of Japan, south of Yeddo. May 12, 1875. Lat. 35° 11′ 0″ N., long. 139° 28′ 0″ E. Depth 345 fathoms. Green mud. Bottom temperature 41°·1 Fahr.; surface temperature 64°·2 Fahr.

Remarks.—*Astropecten brevispinus* is distinguished from the other species in this section of the genus *Astropecten* by the single lateral spine, by the character of the adambulacral armature, and by the character of the paxillæ. It differs from *Astropecten antillensis* and *Astropecten brasiliensis* in each of these particulars. It is at once distinguished from *Astropecten aurantiacus*, which has a single lateral spine, by the general facies, and by the character of the adambulacral armature; and from *Astropecten erinaceus* and *Astropecten duplicatus* by the single lateral spine and the different character of the spinulation of the infero-marginal plates.

3. *Astropecten polyacanthus*, Müller and Troschel.

Astropecten polyacanthus, Müller and Troschel, 1842, System der Asteriden, p. 69.
Astropecten hystrix, Müller and Troschel, 1842, System der Asteriden, p. 70.
Astropecten armatus, Müller and Troschel, 1842, System der Asteriden, p. 71.
Astropecten vappa, Müller and Troschel, 1843, Archiv f. Naturgesch., Jahrg. ix., Bd. i. p. 119.
Astropecten chinensis, Grube, 1865, Jahres-Ber. Schles. Gesellsch. f. vaterl. Cultur, p. 36.
Astropecten ensifer, Grube, 1865, Jahres-Ber. Schles. Gesellsch. f. vaterl. Cultur, p. 36.

Localities.—Port Jackson, Australia. Depth 2 to 11 fathoms, 6 to 15 fathoms.
Admiralty Islands. Depth 16 to 25 fathoms.
Yokohama, Japan. Depth 5 to 25 fathoms.
Kobé, Japan. Depth 8 to 50 fathoms.
Hong Kong. Beach.

Remarks.—The examples from the Admiralty Islands are remarkable for the robustness and size of the large spines on both the supero-marginal and infero-marginal plates. This is especially conspicuous in one example in which the lateral spines are unusually broad and flattened, the breadth being maintained until near the tip, when it abruptly forms a broad lancet-like point. The same example is also noteworthy from the fact that each supero-marginal plate is armed with a spine; whereas another dredged at the same time follows the usual rule in this species in having the second, or second and third, supero-marginal plates on each side of the median interradial line unarmed. These points are very interesting, but I scarcely feel justified in giving a name to the variety on the strength of the material at command. This course, however, may perhaps be found desirable in the future, when more examples from this locality are available for study.

There is a small *Astropecten* also from the Admiralty Islands, which, from having been dredged in association with the above-mentioned specimens, might not unreasonably be looked upon as the young phase of this species. I consider, however, that it is distinct, and should be referred to *Astropecten velitaris*, von Martens. The example in question, which has a major radial measurement of 11 mm., and sixteen supero-marginal plates, has only the two innermost plates in each interbrachial arc armed with spines, no trace of their presence being found on any of the others. This view is strengthened by the fact that in young examples of *Astropecten polyacanthus* from Port Jackson of even smaller size than this, the supero-marginal plates are characteristically and powerfully armed; and the characters of the paxillæ and of the spinulation of the infero-marginal plates are also different.

The type-specimen of Müller and Troschel's *Astropecten vappa* in the Berlin Museum is quite a young form and in bad condition. After the study of the large series of specimens from Australia, I have no hesitation whatever in regarding the name as a synonym of the present species, although the type-specimen could independently be scarcely held as available for specific recognition. I have also examined the types of Grube's *Astropecten chinensis* and *Astropecten ensifer* in Breslau, and I consider that both of them are with little doubt young stages of *Astropecten polyacanthus*.

4. *Astropecten pectinatus*, Sladen (Pl. XXXIII. figs. 3 and 4; Pl. XXXVII. figs. 4–6).

Astropecten pectinatus, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 251.

Rays five. R = 48 mm.; $r = 14$ mm. $R > 3{\cdot}5\ r$. Breadth of a ray at the base, 16·5 mm.

Rays broad at the base, tapering continuously to the extremity, which is finely pointed. Interbrachial arcs subacute or very slightly rounded.

The paxillæ of the abactinal area are large and uniform, and are arranged in regular transverse lines which extend up to the median line of the ray. The paxillæ have a large tabular surface on which are placed twelve to fifteen short papilliform spinelets, and the periphery is surrounded by about an equal number of similar spinelets. In the centre of the disk the paxillæ are smaller, and are very compactly placed. There is no trace of any anal puncture, and no protuberance occurs in the centre of the disk.

The supero-marginal plates, which are twenty-one in number from the median interradial line to the extremity, are higher than broad, the disparity being greatest in the interbrachial arc and diminishing towards the extremity. When seen abactinally the plates have the appearance of being slightly oblique in relation to the direction of the ray, and each, excepting the two innermost, is slightly convex or submammillate at the outer angle formed by the junction of the abactinal and lateral superficies of the plate, which falls in the marginal contour of the ray. On the summit of this convexity is borne a small conical spinelet; and although normally the series of spinelets is continuous throughout the ray, a plate occasionally occurs on which the spine is wanting. The two inner supero-marginal plates are narrower abactinally than the others, and the spinelets they bear are slightly longer and more robust.

The infero-marginal plates are broader than high, and do not extend laterally beyond the superior series. Each plate bears an oblique comb of four or five lateral spines, their line of base forming an angle of about 45° passing from the adoral side to the aboral side of the plate. The adoral spine is the smallest and the most outward, and the third from the margin the longest, the second is intermediate in size, and the fourth nearly as long as the third. A fifth and much smaller spine is situated on the aboral side of the plate a little distance from the comb or lateral series; and on the inner portion of the ray one or even two similar isolated spines may be present on the aboral side of the plate in lineal series. All these spines, as well as the lateral series, are elongate, delicate, cylindrical, and taper to a fine point; and the lateral spines are very slightly bent. The whole of the surface of the infero-marginal plates is compactly covered with small, flat, roundly tipped squamules, uniform and closely placed.

The armature of the adambulacral plates is arranged in three distinct series, with three spinelets in each. The spines of the inner series are of moderate length, the middle one being slightly longest, subcylindrical, and slightly tapering, whilst the companion spinelets are often slightly flattened. The second series consists of three equal spinelets,

which are shorter than the furrow series, and are flat and expanded towards the tip, which is roundly truncate. The outer series, likewise of three spines, is similar to the second series, the middle spinelet, however, being usually broader and more flaring than its companions; occasionally there may be an additional small spine present in this series. The furrow series is directed more or less over the furrow; the second series is usually perpendicular; and the outer series is directed outward towards the margin of the ray. There is also a tendency in the spinelets to radiate apart. Consequent on this mode of arrangement, the armature of the adambulacral plates has a very widely expanded character on the whole.

The actinal intermediate plates, which are small and very few in number, are confined to the immediate interradial area. The spinelets that cover them are small, more or less subspatulate in form, and radiate apart.

The mouth-plates are of moderate size, each pair forming a subtubercular prominence, and their whole surface is covered with small, robust, papilliform spinelets, which form two or three lineal series on each plate. These spinelets increase in length towards the inner extremity, the innermost ones not being much longer or more prominent than the rest.

The madreporiform body is very small, and is situated at about one-third of the distance from the margin to the centre, and sometimes rather further away from the margin even than this. In some specimens there is a faint depression along the median line of a ray; and in large examples a similar slight sulcus occurs on the outer portion of the median interradial line.

Colour in alcohol, a light purplish shade, of which only a trace remains in some specimens, the rest being almost ashy white.

Localities.—Port Jackson. Depth 6 to 15 fathoms.

Station 161. Off the entrance to Port Philip. April 1, 1874. Lat. 38° 22′ 30″ S., long. 144° 36′ 30″ E. Depth 38 fathoms. Sand. Surface temperature 63°·5 Fahr.

Station 162. Off East Moncœur Island, Bass Strait. April 2, 1874. Lat. 39° 10′ 30″ S., long. 146° 37′ 0″ E. Depth 38 to 40 fathoms. Sand and shells. Surface temperature 63°·2 Fahr.

Remarks.—This species is perhaps most nearly related to *Astropecten peruvianus*, Verrill, but is distinguished by the character of the adambulacral armature and by the proportions of the lateral spines. It is distinguished from all the other pectinated species of *Astropecten* by the single continuous series of spinelets on the supero-marginal plates.

5. *Astropecten acanthifer*, Sladen (Pl. XXXIV. figs. 1 and 2; Pl. XXXVIII. figs. 1–3).

Astropecten acanthifer, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 253.

Rays five. R = 90 mm.; r = 14 mm. R > 6·5 r. Breadth of a ray at the base, 14·5 mm.

Rays elongate and tapering. Disk very small. Interbrachial arcs acute.

The paxillæ of the abactinal area are large, and form a compact surface. Each consists of four or five short granuliform spinelets in the centre of the tabulum, surrounded by a circle of a dozen or more short, delicate, obtuse spinelets, the central four having a rather isolated appearance within the circle. A large conical prominence is present in the centre of the disk.

The supero-marginal plates, which are forty-three in number from the median interradial line to the extremity, are rather higher than broad. Each plate bears on the outer abactinal margin (or rounded angle that falls in the marginal contour) a single, small, delicate, conical and sharply pointed spine. The series of spines is continuous throughout the ray; and the two innermost spinelets are rather more robust than the others.

The infero-marginal plates are broader than high, and do not extend beyond the superior series. Each bears three lateral spines close together in transverse series; the outermost, or lateral spine proper, is long, delicate, cylindrical, tapering to a sharp point and slightly bent; the second, which stands immediately behind, is about two-thirds the length and precisely similar; the third spine is very small, not more than one-third the length of the preceding, and is hardly worthy of being ranked as a lateral spine. Sometimes a small spinelet, similar to the last-mentioned, stands by the side of the second lateral spine. No other spinelets are present on the infero-marginal plates, excepting a single isolated spinelet in the median line and near the inner end of the plate adjacent to the adambulacral plates. This spinelet is cylindrical, tapering, sharply pointed, and somewhat longer and more robust than the third lateral spine; its presence and isolation give a very characteristic appearance. The surface of the infero-marginal plates is covered with small and not very closely crowded papilliform squamules, which increase slightly in length and robustness at the inner end of the plate near the adambulacral plates.

The spines of the adambulacral armature are not very large or prominent. Those of the inner or furrow series are three in number, delicate, cylindrical and tapering; and the middle spine is slightly more prominent in the furrow than its companions. The outer spinelets on the actinal surface of the plate are difficult to formulate in consequence of the irregularity in their mode of arrangement. Normally a second and an outer series are present, having about three spinelets in each; but these are often placed in such a way as to appear to give two to the second series, and four, arranged diamond-wise, to the outer series; frequently also one or two small additional spinelets may be present, usually in the latter series, which then forms a group. The spines of the second series, which are shorter than those of the inner series, are slightly compressed and faintly subspatulate. The outer spinelets are shorter than the preceding ones, and are not flattened; their length near the middle of the ray is very slightly in excess of the length of the papilliform squamules of the adjacent infero-marginal plate.

Very few actinal intermediate plates are present, and these bear spinelets similar to

the outer spinelets of the adambulacral armature, which are usually grouped together into an incipient pedicellaria (?).

The mouth-plates are elongate, and covered with comparatively long, closely placed spines, which are flattened and more or less subspatulate. The two inner spinelets, placed side by side on each plate, are longer and larger than the rest ; and these, together with their smaller lateral companions, form a horizontal comb of six to eight spinelets directed towards the centre of the mouth. Behind these inner spinelets follow two or three shorter spines in lineal series on the surface of the plate ; these are succeeded by eight or nine pairs of short, flat spines, closely placed and occupying the middle portion of the surface, on which they stand perpendicularly ; and the outer part of the plate carries three or four spines in single line directed outward, their length and robustness increasing as they recede from the mouth. The next adambulacral plate to the mouth-plates is narrow, and the spines thereon are small, uniform, and arranged in two lineal series apposed to one another.

The madreporiform body is obscured by paxillæ.

The ambulacral tube-feet are small and terminate in a point, which is tipped with black, and gives a very singular appearance to the species.

The terminal plate has a slight furrow abactinally, suggesting the line of union of two primitive plates.

Colour in alcohol, yellowish grey.

Locality.—Station 192. In the Banda Sea, between the Ki Islands and Banda Islands. September 26, 1874. Lat. 5° 49′ 15″ S., long. 132° 14′ 15″ E. Depth 140 fathoms. Blue mud. Surface temperature 82°·0 Fahr.

Remarks.—This species has some alliances with *Astropecten scoparius* and *Astropecten mauritianus*, but is distinguished by the spinulation of the infero-marginal plates, and by the character of the armature of the adambulacral plates.

6. *Astropecten japonicus*, Müller and Troschel.

Astropecten japonicus, Müller and Troschel, 1842, System der Asteriden, p. 73.

Localities.—Station 233. Off Kobé, Japan. May 17, 1875. Lat. 34° 39′ 0″ N., long. 135° 14′ 0″ E. Depth 8 fathoms. Mud. Surface temperature 62°·3 Fahr.

Station 233A. North of Awadji Sima. May 19, 1875. Lat. 34° 38′ 0″ N., long. 135° 1′ 0″ E. Depth 50 fathoms. Sand. Surface temperature 62°·6 Fahr.

Station 233B. In the Bingo Nada. May 26, 1875. Lat. 34° 18′ 0″ N., long. 133° 35′ 0″ E. Depth 15 fathoms. Blue mud. Surface temperature 66°·3 Fahr.

Off Yokohama, Japan. Depth 8 to 14 fathoms, 5 to 25 fathoms.

Remarks.—A large series of this species was obtained. I have compared them with the original type-specimens of Müller and Troschel belonging to the Leyden Museum.

7. *Astropecten imbellis*, Sladen (Pl. XXXIV. figs. 3 and 4; Pl. XXXVIII. figs. 4–6).

Astropecten imbellis, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 255.

Rays five. R = 24 mm.; r = 7 mm. R > 3·5 r. Breadth of a ray at the base, about 7 mm.

Rays rather narrow, especially on the outer part, tapering continuously from the base to the extremity. Interbrachial arcs subacute.

The paxillar area has a comparatively open and irregular appearance, in consequence of the character of the paxillæ; these have short thin pedicles, scarcely forming a true tabulum, and are surmounted by eight to ten rather long delicate spinelets, much longer than the pedicle, which do not usually radiate apart widely. In consequence of the rather wide separation of the paxillæ, a somewhat "draggled" appearance is produced. In the centre of the disk the paxillæ are rather smaller and more crowded, and a central eminence is present.

The supero-marginal plates, which are eighteen in number from the median interradial line to the extremity, are about as broad as high, but higher on the inner part of the ray. The plates are slightly tumid, and form a well-rounded margin to the ray. The surface of the plates is covered with very fine, closely placed, papilliform granules; and the innermost eight or nine supero-marginal plates bear a small, delicate, sharply pointed spinelet, about equal in length to the length of the plate, and placed near the middle of the abactinal portion of the plate. The breadth of the plates is very little greater than the length on the inner portion of the ray; and on the outer portion these proportions are reversed.

The infero-marginal plates are broad, gently rounded towards the actinal surface, and do not extend beyond the superior series. They bear three lateral spines, placed close together in a very oblique series, the second from the margin being slightly the longest and most robust; all are exceedingly delicate, needle-like, and very faintly bent, the longest being rather more than twice the length of the plate. On the innermost three plates the upper or outer spine is the longest; it is also flattened and much broader than elsewhere. Excepting on the innermost three plates no other spines occur; on these, however, one or two very small ones are present in the median line. The surface of the infero-marginal plates is covered with numerous minute papilliform squamules closely placed, which become more spiniform towards the margins.

Not more than two or three actinal intermediate plates are present, and these are covered with short, papilliform spinelets similar to those just mentioned.

The armature of the adambulacral plates consists of short, delicate, cylindrical spines, slightly tapering at the tips, which form two series. The inner series consists of three spines, the middle one slightly longest, radiating apart and directed over the furrow. The outer series consists likewise of three similar and equal spinelets, usually directed towards

the margin of the ray; and occasionally there may be one or two supplementary spinelets, usually smaller and almost indistinguishable from the spinelets of the infero-marginal plates, but occasionally one is as large as the three spinelets of the outer series, and is irregular in position.

The mouth-plates are small, and form a prominent narrow keel along the median suture-line, on each side of which are borne two rows of rather elongate cylindrical spinelets, six or seven in each, and two or three in single series on the outer part, which are larger. The innermost spinelets are more robust than the others, but only very slightly longer, and no prominent horizontal comb is formed over the mouth-opening as in other species. There is a row of five to seven rather elongate spinelets on the free margin of the mouth-plate.

The madreporiform body, which is small and almost hidden by paxillæ, is situated rather more than its own breadth from the margin.

The ambulacral tube-feet are moderately robust and have conical pointed tips.

The terminal (ocular) plate is rather large, and broader than long; distinctly appearing as if formed by the lateral union of two semicylindrical plates, with a rather large tubercular granule on each side at the extreme tip, on which spinelets were probably articulated.

Colour in alcohol, yellowish grey, with a darker tint over the paxillar area approaching greenish grey.

Locality.—Station 204. Off Tablas Island (Philippine group). November 2, 1874. Lat. 12° 43′ 0″ N., long. 122° 9′ 0″ E. Depth 100 fathoms. Green mud. Surface temperature 84°·0 Fahr.

Remarks.—This form is distinguished from the other species possessing a non-continuous series of spines on the supero-marginal plates by the absence of the spines in question on the outer half of the ray, and by the presence of the oblique series or comb of lateral spines on the infero-marginal plates.

8. *Astropecten hermatophilus*, Sladen (Pl. XXXIII. figs. 5 and 6; Pl. XXXVII. figs. 7–9).

Astropecten hermatophilus, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 257.

Rays five. R = 25 mm.; r = 8 mm. R > 3 r. Breadth of a ray at the base, 8·5 mm.

Rays of moderate breadth, tapering from the base to the extremity, but not becoming attenuate or sharply pointed. Interbrachial arcs slightly rounded.

The paxillar area is compact and uniform, rather more than three times the breadth of the supero-marginal plates at the middle of the ray. The paxillæ are longer on the disk and along the median abactinal line than at the sides of the rays, where they are arranged in

regular transverse rows, about five in each. The larger paxillæ have a circlet of ten to twelve short spinelets surrounding a rather large tabulum, on which one to three low granules are placed; and the smaller ones have about eight, with one central. The paxillæ are smaller and very compact in the centre of the disk, and a prominent conical peak is present.

The supero-marginal plates, which are twenty-two or twenty-three in number from the median interradial line to the extremity, are slightly broader than long; their height is greater than the length, and increases on the inner portion of the ray, where it is greater than the breadth. The plates are slightly tumid and well-defined; and are covered with low rounded granules, which are larger and more prominent on the middle of the plate. Normally each plate bears a prominent spiniform granule on the rounding that unites the abactinal and lateral surfaces; and occasionally a second may be present close beside it. Usually one or two of the innermost plates on each side of the median interradial line carry two of these spiniform granules, of equal size.

The infero-marginal plates do not protrude beyond the line of the superior series, and are gently rounded towards the actinal area. Each plate has a single, short, slightly compressed, and sharply tapering lateral spine, followed by two similar but shorter spinelets, placed close behind, and forming a line slightly oblique to the median line of breadth of the plate. The second spine is about two-thirds the length of the lateral spine, and the third is much less and more compressed. This triplet of spines is confined to the marginal edge of the plate, and no other spines are present, except on one or two of the innermost plates, the rest of the plate being covered with small uniform squamules, and these, though short, are more or less spatuliform and have rounded tips.

Only two or three actinal intermediate plates are present, and these bear small, uniform, papilliform spinelets.

The armature of the adambulacral plates consists of short spines, which normally form two series; but on some plates the outer series is somewhat irregular, and the arrangement may simulate the appearance of three series. The inner or furrow series consists of three spines, of which the middle one is longest, straight, cylindrical and tapering; whilst the two lateral ones are short, delicate, compressed in the direction of the axis of the ray, slightly expanding towards the tip, and truncately rounded. The outer series consists of three spines, equal in size, broad, robust, flatly compressed in the direction of the axis of the ray, widely flaring towards the extremity, and truncate. The middle spinelet is on some plates placed external to the two lateral ones, and sometimes in consequence appears like a solitary spinelet of a third series. Sometimes also the aboral lateral spinelet may be slightly in advance. On a few of the innermost plates one or two supplementary spinelets may be present.

The mouth-plates are large and prominent, with a single line of short, robust, papilliform spinelets upon the surface of the keel, along each side of the median suture; these

are about ten or eleven in number, and decrease in size adorally and aborally. Of the mouth-spines proper, situated on the free margin of the plates, the innermost three on each side of the suture-line are long, robust, cylindrical, obtusely rounded, and form, together with the corresponding spines of the companion plate, the comb which stretches horizontally over the mouth-aperture. On the remaining portion of the free margin are three or four small, equal-sized, cylindrical spines. The first adambulacral plate next to the mouth-plate is narrow, with a biserial armature, consisting of about eight small, compressed, slightly flaring, and truncate spines in each row.

The madreporiform body is transversely oval in form, and not more than its own breadth distant from the marginal plates.

The terminal plate is large and broad, very deeply channelled anteriorly, and with two or three short robust spinelets, which curve slightly over the furrow.

Colour in alcohol, very light ochre-brown, almost verging towards grey.

Locality.—Station 75. Between the islands of Fayal and San Jorge (Azores). July 2, 1873. Lat. 38° 38′ 0″ N., long. 28° 28′ 30″ W. Depth 450 fathoms. Volcanic mud. Surface temperature 70°·0 Fahr.

Remarks.—This species is characterised by the single short, compressed, lateral spine, with two closely placed small companions, by the broad and flaring spinelets on the actinal surface of the adambulacral plates, and by the absence of an aboral line of spinelets on the infero-marginal plates. The form is very nearly allied to *Astropecten irregularis*, Linck, but is distinguishable by many points of detail when examples of the two species are compared side by side.

9. *Astropecten irregularis*, Linck.

Astropecten irregularis, Linck, 1733, De Stellis marinis, p. 27, tab. vi. fig. 13.
Asterias aranciaca, O. F. Müller, 1776, Zool. Dan. Prod., p. 234, No. 2831.
Astropecten Mülleri, Müller and Troschel, 1844, Archiv f. Naturgesch., Jahrg. x., Bd. i. p. 181.
Astropecten echinulata, Müller and Troschel, 1844, Archiv f. Naturgesch., Jahrg. x., Bd. i. p. 181.

Localities.—"Porcupine" Expedition:

Station 18. Off the west coast of Ireland, north-west of Achill Head. Lat. 54° 15′ N., long. 11° 9′ W. Depth 183 fathoms. Bottom temperature 9°·7 C.; surface temperature 11°·8 C.

Station 46. Between Scotland and the Faeröe banks. Lat. 59° 23′ N., long. 7° 4′ W. Depth 374 fathoms. Bottom temperature 7°·7 C.; surface temperature 12°·1 C.

Station 67. East of the Shetland Islands. Lat. 60° 32′ N., long. 0° 29′ W. Depth 64 fathoms. Bottom temperature 9°·5 C.; surface temperature 11°·0 C.

Station 68. East of the Shetland Islands. Lat. 60° 23′ N., long. 0° 33′ E. Depth 75 fathoms. Bottom temperature 6°·7 C.; surface temperature 11°·4 C.

Remarks.—These are all small forms and have a certain facies of their own, but they

do not possess the characters diagnosed by Dr Norman in the description of his *Astropecten acicularis*.[1] I have therefore referred them to the older type.

Sir Wyville Thomson[2] expresses very definitely his belief that *Astropecten acicularis* is merely a deep-water variety of *Astropecten irregularis;* and states that a magnificent series was procured by Mr Waller in 1869 during a dredging cruise off the south coast of Ireland, showing a gradual transition through all intermediate stages between the large and the small varieties.

10. *Astropecten pontoporæus*, Sladen (Pl. XXXV. figs. 1 and 2; Pl. XXXVIII. figs. 10–12).

Astropecten pontoporæus, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 259.

Rays five. R = 53 mm; r = 15 mm. R = 3·5 r. Breadth of a ray at the base, 16·5 mm.

Rays rather broad throughout, and only slightly tapering until near the extremity, which, although pointed, is rather obtuse. Interbrachial arcs subacute, or with a faint tendency to rounding.

The paxillar area is wide and extensive, with numerous, rather small, compact paxillæ. The spinelets of which these are composed are short and uniform. The larger paxillæ have a circlet of twelve to fourteen spinelets surrounding seven or eight on the centre of the tabulum; and the smaller paxillæ present about half these numbers. Along the sides of the rays the paxillæ are arranged in regular transverse lines, about five or six in each. The paxillæ diminish greatly in size in the neighbourhood of the centre of the disk and towards the ends of the rays.

The supero-marginal plates, which are twenty-seven or twenty-eight in number from the median interradial line to the extremity, are broader than long; and their height is about equal to the breadth at mid-arm, but greater on the inner portion of the ray. The plates are well-rounded and tumid, which gives them a crested or subtubercular appearance, and clearly defines the separate plates. The plates are covered with small papilliform granules, which decrease in size towards the margins; and each plate normally bears an elongate granule or aborted spinelet, situated rather low down on the curve which unites the abactinal and lateral surfaces of the plate; but not unfrequently two or three may be present, and these stand in transverse line along the median line of breadth.

The infero-marginal plates are broad, rather sharply rounded towards the actinal surface, and do not protrude beyond the level of the superior series. Each bears four or five lateral spines standing in an oblique line, only slightly inclined to the axis of the ray, passing from the adoral to the aboral side of the plate. The spines are short, cylindrical, tapering, and pointed; the third or fourth from the adoral end of the line is the longest,

[1] *Ann. and Mag. Nat. Hist.* 1865, ser. 3, vol. xv. p. 116.

[2] The Depths of the Sea, 1873, p. 121.

although there is no great disparity in the length of any of them excepting the first, which is very small. Two or three irregular rows, with the spinelets in each shorter than those in the preceding row, stand behind the lateral series, and form a gradual transition into the spiniform squamulation of the plate. Consequent on this arrangement the lateral spines have a short, compact, and almost tufted appearance, whilst the series forms a thick and closely crowded fringe along the ray. The squamules of the infero-marginal plates are rather long, flat, and rounded, or obtusely pointed at the extremity, and although numerous they are not very closely placed. Three or four more prominent squamules, simulating spinelets, form a line along the aboral margin of the plate, and occasionally similar ones may be found here and there on other parts of the plate.

Not more than six or eight actinal intermediate plates are present, and they carry very small, short, and equal-sized papilliform spinelets, which appear to form a kind of pedicellaria.

The armature of the adambulacral plates consists of short spines, which are arranged in two series. The inner series consists of three spines, which are short, cylindrical, slightly taper and obtuse, the middle one being more robust, compressed laterally, geniculate and prominent in the furrow. The outer series near the middle of the ray has three spines which are equal to, or rather longer than, the inner series, but more robust, slightly compressed, and obtusely rounded at the tips; these run obliquely across the plate, the adoral spinelet often being in the position of a third series. On the inner portion of the ray one or two supplementary spinelets may be present, external to the oblique line of three spines above mentioned.

The mouth-plates are elongate, and form a long, prominent, narrow keel along the line of suture. Upon the keel there is a single line of spinelets on each plate, which are rather long, robust, compressed, and subpapilliform; these are seven to nine in number, and they diminish in size aborally. On the outer free margin of the plate there are about eight spinelets—the innermost three, which with the corresponding spinelets of the companion mouth-plate form the comb of spines projecting horizontally over the mouth, are longer than the rest, and are slightly curved inward at their extremities in the direction of the horizontal plane of the mouth-area. The remaining spinelets are much smaller and equal-sized, and the series does not reach beyond a line drawn at right angles through the middle of the median suture-line.

The armature of the first adambulacral plate beyond the mouth-plates consists of fifteen or more pairs of small, equal, papilliform spinelets, ranged in two parallel lines, and apposed to one another, which form a remarkably elegant organ, probably of pedicellarian functions. On the outer portion of the second adambulacral plate there is a partial repetition of this arrangement.

The madreporiform body is small, but tubercular, and is situated nearer the margin than midway to the centre.

The terminal plate, which is moderately large and broad, is deeply grooved at the extremity.

Colour in alcohol, yellowish white.

Locality.—Simon's Bay, Cape of Good Hope. Shallow water, 5 to 20 fathoms.

Remarks.—The nearest ally of this form appears to be *Astropecten serratus*, Müller and Troschel, from which, however, it may, in my opinion, be distinguished by the characters of the supero-marginal plates, of the spinulation of the infero-marginal plates, and of the armature of the adambulacral plates. The rays also are shorter and broader.

11. *Astropecten zebra*, Sladen (Pl. XXXVI. figs. 3 and 4; Pl. XXXIX. figs. 7–9).

Astropecten zebra, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 261.

Rays five. R = 34 mm.; $r = 9$ mm. R = 3·7 r. Breadth of a ray at the base, about 9 mm.

Rays rather narrow, and although tapering gradually from the base to the extremity, the tip is comparatively obtuse. Interbrachial arcs distinctly rounded.

The paxillæ of the abactinal area are large, having one to four, or even more, central spiniform granules on the tabulum, surrounded by eight to twelve short spinelets in a circle on the periphery. A slight prominence is present in the centre of the disk of some specimens, but scarcely sufficient to produce a conical peak. In one specimen a slight invagination occurs in the centre of the prominence.

The supero-marginal plates, which are twenty-five in number from the median interradial line to the extremity, are higher than broad, and have the appearance of forming a rounded sloping bevel to the ray, especially in the interbrachial arc. The plates are uniformly covered with papilliform granules, and bear no spines or tubercles whatever, excepting the innermost four plates on each side of the median interradial line. These four or five plates are armed with a short, conical, and slightly compressed spinelet, the innermost being longest, and the others decreasing in size as they proceed outward.

The infero-marginal plates are much broader than high, and do not extend beyond the superior series, although in large specimens there is a tendency to appear to do so in consequence of the presence of a slight prominence on the plate on which the lateral spine is articulated. There is one lateral spine of moderate length, which tapers throughout, is sharply pointed, cylindrical, and very slightly flattened; this is accompanied by a second spine, about two-thirds the length of the lateral spine, placed immediately behind and close to the aboral side of the plate. Two or three small compressed spinelets are situated in line on the aboral side of the plate, that near the inner extremity adjacent to the adambulacral plates often slightly largest. No other spines are present on the infero-marginal plates, which are covered with moderately well-spaced squamules.

The armature of the adambulacral plates is arranged in three series on the inner part of the ray, but becomes reduced to two on the outer portion. The inner or furrow series consists of three spinelets, which are rather short—the middle one delicate and clavate at the extremity, and the two lateral companions rather shorter, flat and obtuse. The second series consists of two or three spinelets shorter than the inner series, and more or less flattened and truncate. When a third spinelet is present it is very frequently placed somewhat behind the other two, opposite their interspace; and might almost be ranked with the third series, which latter may consist of only two or three small cilia-like spines, or of four flat modified spines, forming a well-developed pedicellaria. These organs are irregular in their occurrence, and are only present on the inner half of the ray; on the outer part of the ray the third series of spines of the adambulacral armature is apparently wanting altogether. The pedicellariæ are large and conspicuous, and four or five are present along each side of a furrow, usually on alternate plates; all are uniform, and with four valves, regularly apposed two and two, the spinelets which form the valves being more or less flattened and arched, and terminating in an abruptly pointed or lanceolate extremity.

Very few actinal intermediate plates are present; the two immediately behind the mouth-plates each bear a large pedicellaria similar to those just mentioned.

The mouth-plates are elongate and narrow, with a single line along their superficies of comparatively long and robust spinelets, which are cylindrical or slightly compressed and obtuse; all are nearly uniform in size excepting the innermost one or two, which are somewhat larger than the others.

Colour in alcohol, a very light brown or chocolate colour on the paxillar area, which is mottled with spots and lines of a darker tint of the same. These marks fall in a line parallel to, and midway between, the marginal plates and the median radial line. On the inner third of the ray the line or band of colour is generally continuous and meets the corresponding band of the adjacent ray on the disk, forming a V-shaped mark, thickened in the angle. On the outer part of the ray the markings are discontinuous, forming spots, and these frequently extend up to and over the marginal plates. The actinal surface and ambulacral tube-feet are yellowish white.

Young Phase.—A small specimen measuring R = 11 mm., which has twelve supero-marginal plates, as yet possesses no trace whatever of the conspicuous spines present on the supero-marginal plates in the interbrachial arc of the adult form. On the infero-marginal plates there is no indication of the aboral line of spinelets, only a single well-developed lateral spine accompanied by a very small companion. No pedicellariæ are yet to be found on the adambulacral plates; but a pair of actinal intermediate plates are very conspicuous, and the papilliform spinelets they bear are very robust and are grouped in such a way as to lead to the inference that they perhaps performed the functions of a pedicellarian organ. The rays are shorter and broader at the base in this young form as compared with the adult stages.

Locality.—Station 186. In Torres Strait, off Cape York. September 8, 1874. Lat. 10° 30′ 0″ S., long. 142° 18′ 0″ E. Depth 8 fathoms. Coral mud. Surface temperature 77°·2 Fahr.

Remarks.—*Astropecten zebra* is distinguished from *Astropecten velitaris* by the three or four comparatively large flattened spines on the supero-marginal plates on each side of the median interradial line, and by the presence of the well-developed pedicellariæ; and it is distinguished from *Astropecten fragilis* by the single lateral spine, and by the spinelets in the aboral series on the infero-marginal plates increasing in length as they approach the margin. The armature of the adambulacral plates is also different.

11*a*. *Astropecten zebra*, var. *rosea*, Sladen.

Astropecten zebra, var. *rosea*, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 263.

The examples of *Astropecten zebra* from Station 186 are very constant in their characters. The specimens from Station 187 (three in number) present some variation. In colour they are a rosy brown, approaching madder-brown, and the markings are dark brown. The actinal surface is a delicate rosy pink, and the tube-feet are a rich scarlet. The rays are slightly broader, and taper rather more rapidly at the tip. Only the innermost two or three supero-marginal plates bear spines, which are smaller and almost invisible excepting the innermost. The small spinelets on the aboral margin of the infero-marginal plates do not form the continuous line noted in the specimens from Station 186, but are wanting in the median portion, thus leaving the spinelet near the adambulacral plates isolated, and the spinelet near the lateral spines is relatively larger and might almost be counted along with the laterals.

Locality.—Station 187. In Torres Strait. September 9, 1874. Lat. 10° 36′ 0″ S., long. 141° 55′ 0″ E. Depth 6 fathoms. Coral mud. Surface temperature 77°·7 Fahr.

12. *Astropecten velitaris*, von Martens.

Astropecten velitaris, von Martens, 1865, Archiv f. Naturgesch., Jahrg. xxxi., Bd. i., p. 360.

Localities.—Amboina. Depth 100 fathoms, 15 to 25 fathoms.

Admiralty Islands. Depth 16 to 25 fathoms.

Remarks.—Dr von Martens when describing this species suggested, with his customary care and foresight, that owing to the small size of his type (R = 16 mm.) it might possibly be thought that *Astropecten velitaris* would ultimately prove to be the young phase of some other species, such for instance as *Astropecten armatus*, Müller and Troschel (*i.e.*, *Astropecten polyacanthus*). In support of the view that it is a distinct species, or at any rate not the young of *Astropecten polyacanthus*, I may here mention that small examples of *Astropecten polyacanthus* from Port Jackson, the smallest measuring about R = 8 to 9

mm., have fully developed spines on all the supero-marginal plates, excepting the second and third, and are quite recognisable specifically.

Lütken[1] has also supported the view of the independence of the species by giving a description of a much larger example than that discovered by von Martens.

13. *Astropecten granulatus*, Müller and Troschel (Pl. XXXV. figs. 3 and 4; Pl. XXXIX. figs. 4–6).

Astropecten granulatus, Müller and Troschel, 1842, System der Asteriden, p. 75.

Locality.—Station 188. In the Arafura Sea, between Cape York and Frederick Henry Island. September 10, 1874. Lat. 9° 59′ 0″ S., long. 139° 42′ 0″ E. Depth 28 fathoms. Green mud. Surface temperature 78°·5 Fahr.

Remarks.—Although I have had the opportunity, through the kindness of Professor Schlegel and Dr Jentinck, of comparing Müller and Troschel's original type-specimens of *Astropecten granulatus*, from the Leyden Museum, side by side with the single example obtained by the Challenger, it is not without some hesitation that I refer the latter to that species. It is, however, without any doubt most nearly related to that form, and as the differences are very slight, and appear to me quite of secondary character, such as might in great measure be accounted for by differences of locality, I have considered it preferable, owing to the scantiness of the material, to refer the specimen under notice directly to Müller and Troschel's *Astropecten granulatus*. The adoption of that course is further warranted by the fact that so far as I am aware no other examples except the types are known to exist, and their locality is unknown.

The type-form is well and accurately described by Müller and Troschel, with the exception of the statement that the supero-marginal plates bear small spines: "Die dorsalen Randplatten sind höher als breit, in den Winkeln der Arme sehr hoch, tragen kleine Stacheln und sind überall grob granulirt."[2]

No spines or even rudiments of spines exist, or have existed, upon the supero-marginal plates of the type-specimens, which are well preserved, and are literally "überall grob granulirt." I would venture to suggest that in the passage quoted above, the word "kleine" is a misprint for "keine." With this amendment the diagnosis would stand correct.

The Challenger specimen, which is smaller than either of the types, differs in having rather shorter and broader rays; and the supero-marginal plates are plane or nearly so abactinally, whilst in the type they have a decidedly tumid appearance.

It may further be noticed that these differences are probably greatly emphasised by the fact that the type-specimens are dried and considerably shrunk, whilst the specimen under notice is in spirit and well preserved. In the Challenger example the armature of the

[1] *Videnskab. Medd. naturh. Foren. i Kjøbenhavn*, 1871, p. 237.

[2] System der Asteriden, p. 75.

adambulacral plates is more stumpy in character, and there are usually two unequal, flattened, papilliform spinelets on the actinal surface of the plate, with a smaller one behind them opposite their interspace.

14. *Astropecten monacanthus*, Sladen (Pl. XXXIII. figs. 7 and 8; Pl. XXXVII. figs. 10–12).

Astropecten monacanthus, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 263.

Rays five. R = 26 mm.; $r = 7$ mm. $R > 3{\cdot}5\ r$. Another specimen measures, R = 22 mm.; $r = 6$ mm. Breadth of a ray at the base, 6·25 mm.

Disk moderately large. Rays rather long and narrow, tapering rather rapidly on the outer portion to a pointed extremity. Interbrachial arcs rounded.

The paxillar area is wide, measuring more than three times the width of the supero-marginal plates near the middle of a ray, and is very regular in composition. The paxillæ are large and well-spaced, and have one large granule-like spinelet in the centre of the tabulum, and seven to ten very short clavate spinelets on the circumference radiating out widely, almost horizontally. Occasionally on the disk, paxillæ have two to four central granules; but the single, large-sized, low granule is very characteristic. On the sides of the rays the paxillæ are arranged in transverse lines, about three or four in each; the median radial band is scarcely defined. In the centre of the disk a conical peak is present, in the neighbourhood of which the paxillæ become very small and crowded. In some cases the centre of the cone is invaginated.

The supero-marginal plates, about twenty-three in number from the median interradial line to the extremity, which are small, higher than broad, and not tumid, form an even and well-rounded margin to the ray; their extension on the abactinal surface is small in consequence of the narrowness of the plates. The surface of the plates is covered with large, flat-topped, well-spaced granules, which diminish a little in size at the margins; and the suture or furrow between the neighbouring plates is almost hidden. The usual fine cilia, if present, are entirely concealed. No spinelets or tubercles of any kind are borne on the supero-marginal plates.

The infero-marginal plates, which are much broader than high, do not extend beyond the superior series, and have a sharp subangular rounding towards the actinal surface. Each plate bears a single lateral spine, and no other spines are present, the whole surface of the plate being covered with moderately spaced, small, flat, subacuminate squamules very little longer than broad. Two of the squamules immediately behind the lateral spines are longer than the rest, and subspiniform. There is no tendency to develop spines on any other part of the plate. The lateral spines are short, delicate, subcylindrical, slightly compressed, tapering from the base to a very finely pointed extremity, and are very faintly curved; they are directed horizontally from the ray at right angles to the axis, and are wide apart;

those in the middle of the ray are slightly longer than the others, which decrease in length towards the inner and outer portions of the ray; the longest spines are nearly equal to the length of three infero-marginal plates.

Not more than two or three actinal intermediate plates are present, and these carry small papilliform spinelets, which form an incipient pedicellaria-like group.

The armature of the adambulacral plates consists of short and rather robust spines, which form two distinct series, having three spines in each. The inner or furrow series consists of three short, robust, obtusely tipped spinelets, which radiate apart and arch over the furrow, the middle spine being longest. The outer series consists of three spines much shorter than the inner series; and the middle spinelet, which is slightly the longest and twice as robust as its companions, has a short, flat and subspatulate form. The aboral spinelet is smallest, and is placed in advance of the other two, its position almost suggesting that it ought to be reckoned as belonging to a middle series, an idea which is further strengthened by the presence in the innermost portion of the ray of a minute granule or rudimentary spinelet in a corresponding position on the adoral side of the plate. This arrangement causes the broader middle spinelet at first sight to appear as the aboral of two spines which form a true outer series, directed outward towards the margin of the ray.

The mouth-plates are elongate and narrow, with a single row of eight to ten papilliform spinelets on their surface, which are very small outwardly, but increase in length as they approach the mouth, the innermost spine being longer than any of the others and directed horizontally. The two series of spinelets on the companion plates of a mouth-angle are generally apposed to one another. On the free margin of the mouth-plate there is a lineal series of short, rather robust spinelets, directed horizontally, which increase in length as they approach the inner extremity of the plate; the innermost spinelet being very little shorter than the innermost spinelet of the superior series just mentioned, and standing on the same level, forms together with it the horizontal fan of mouth-spines which proceed from each mouth-angle and cover the mouth. The adambulacral plate adjoining the mouth-plates is much broader and shorter than the others, and bears a lineal series of eight or nine short papilliform spinelets on each side, the two series being apposable.

The madreporiform body is entirely hidden by paxillæ.

Colour in alcohol, ashy grey.

Locality.—Station 203. East of Panay Island, Philippine group. October 31, 1874. Lat. 11° 6′ 0″ N., long. 123° 9′ 0″ E. Depth 20 fathoms. Mud. Surface temperature 85°·0 Fahr.

Remarks.—This species is distinguished from *Astropecten granulatus* by the narrow marginal plates, by the consequently broad paxillar area, and by the comparatively simple character of the paxillæ. The general facies of the two forms is quite different.

15. *Astropecten cingulatus*, Sladen (Pl. XXXV. figs. 5 and 6; Pl. XXXIX. figs. 1–3).

Astropecten cingulatus, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 266.

Rays five. R = 28 mm.; $r = 9$ mm. $R > 3r$. Breadth of a ray at the base, 10 mm.

Rays rather short and of moderate breadth, tapering gently with a slight curve to the extremity, which is sharply pointed. Interbrachial arcs subacute and not rounded.

The paxillar area is very limited in consequence of the great breadth of the supero-marginal plates. The paxillæ are large upon the disk, but become smaller along the rays; the former have four or five rather large granules in the centre on the tabulum, surrounded by a dozen or more small short spinelets. Along the rays there are not more than two or three central granules, and these are arranged in line, the paxilla (tabulum) being more or less elongately oval in the direction of the axis of the ray. The paxillæ are closely placed. In the centre of the disk a small conical elevation is present, upon and in the neighbourhood of which the paxillæ are smaller.

The supero-marginal plates, which are nineteen in number from the median interradial line to the extremity, are all much broader than high, the breadth of those midway on the ray being greater than the adjacent paxillar area. The breadth of the supero-marginal plates increases towards the summit of the interbrachial arc, where the maximum is attained; the innermost plate of each ray, which is contiguous to the median interradial line, is triangular or wedge-formed, the apex being directed outward; whilst the bases of the two adjacent triangles form a wide rounding to the inner contour-line of the marginal wall. The border formed on the abactinal surface by the marginal plates is very broad and conspicuous. The length of the supero-marginal plates in the inner half of the ray is not more than one-third of their breadth. The plates are rather tumid along the median line of breadth, which produces a slight furrow between each; and the surface of the plate is covered with closely placed uniform granules, which become finer along the margins. No spinelets, tubercles, or enlarged granules are present on the plates.

The infero-marginal plates are broader than high, and extend very slightly beyond the superior series. Each bears two lateral spines, standing side by side, which are equal in length, short, very delicate, cylindrical, or faintly flattened, tapering to a sharply pointed extremity, and slightly bent. Behind these stand two or three very small, delicate spinelets; and a row of similar, though somewhat smaller, spinelets is placed on the adoral side of the plate. The surface of the plate is covered with small, flat, subcircular squamules, rather widely spaced, the margins being bordered with crowded, short, delicate, ciliary spinelets, hidden in the divisional furrows.

Only two or three actinal intermediate plates are present in the immediate interradial area: these carry usually one moderately long tapering spinelet, surrounded by a marginal series of papilliform spinelets.

The armature of the adambulacral plates usually forms three series, although the third

or outer series is often absent or indistinguishable from the ciliary spinelets of the infero-marginal plates on the outer part of the ray. The inner or furrow series consists of three spines, which are short, cylindrical, or flattened transversely, slightly taper, the middle one a little longer than the companion spines, and standing forward prominently in the furrow. The second series has usually two spines standing wide apart, opposite the two outer spines of the furrow series: these spines are shorter than the inner trio, flattened in the plane of the axis of the ray, do not taper, and are roundly truncate at the extremity. Sometimes a third spinelet, similar in size and shape, is present between them. The outer series consists of three small papilliform spinelets, which are only slightly longer and more robust than the transitional or ciliary spinelets above mentioned.

The mouth-plates are small and narrow, with a single line of rather long compressed spinelets standing perpendicular to the superficies, excepting those near the inner extremity, which are directed horizontally over the mouth, and are also larger and more robust; those at the outer extremity are directed outward. Low down on the sides are a few small and irregular supplementary spines.

The madreporiform body is about its own width distant from the marginal plates, and is almost hidden from view by the paxillæ.

Colour in alcohol, almost pure white.

Locality.—Station 122–122c. Off the coast of Brazil, south-east of Pernambuco. September 10, 1873. Lat. 9° 5′ 0″ S. to 9° 10′ 0″ S., long. 34° 49′ 0″ W. to 34° 53′ 0″ W. Depths, 32, 120, 350, 400 fathoms. Red mud. Surface temperature 77°·5 Fahr.

There is unfortunately no indication as to which of these dredgings the specimen came from.

Remarks.—This form is readily characterised by the remarkably broad border of large marginal plates, and by the two small, delicate, sharply pointed, lateral spines, placed side by side, as well as by the character of the adambulacral armature and the spinulation of the infero-marginal plates.

16. *Astropecten mesactus*, Sladen (Pl. XXXIV. figs. 5 and 6; Pl. XXXVIII. figs. 7–9).

Astropecten mesactus, Sladen, 1883, Journ. Linn. Soc. Lond. (Zool.), vol. xvii. p. 267.

Rays five. R = 34 mm.; r = 11 mm. R > 3 r. Breadth of a ray at the base, about 11 mm.

Disk of moderate size and somewhat tumid. Rays rather short and moderately broad at the base, tapering continuously to a finely pointed extremity. Interbrachial arcs rounded.

The paxillar area is extensive over the disk, and contracts rapidly along the rays, terminating in a point, in conformity with the shape of the starfish. The paxillæ are moderately large, with a broad tabulum bearing in the centre one, or occasionally two isolated granules, and surrounded by eight to twelve short, claviform spinelets around the

margin, which radiate outward slightly. There is a little diminution in the size of the paxillæ towards the centre of the disk, but no trace occurs of any epiproctal prominence or peak whatever. The paxillæ are arranged in very short transverse rows at the sides of the rays, the irregular median space being wide. The paxillæ become very small towards the ends of the rays.

The supero-marginal plates, which are twenty-one in number from the median interradial line to the extremity, are small, about as broad as high, and slightly tumid. They are covered with papilliform granules, which are uniform in size and shape, and not very closely placed; and fine cilia are present in the furrows between successive plates. No spines or tubercles of any kind are present on the supero-marginal plates.

The infero-marginal plates are broader than high, the height being proportionately greater than usual in the genus; they do not extend beyond the level of the superior series, and form a gently rounded curve towards the actinal surface. The lateral spines, which are very small, short, taper, and slightly compressed, are four in number, placed close together in an oblique line, passing from the adoral extremity of the marginal end to the aboral side of the plate, the third from the margin being the longest; the fourth spine is usually rather shorter than the third, but sometimes equal. These spinelets, though not closely appressed to the side of the ray, stand at an angle to the surface and are directed somewhat upward and outward. Behind the line of lateral spines is a line of small, flattened, spiniform squamules, larger than the general squamules of the plates; and on the inner part of the ray one or two similar spinelets may be found on the inner portion of the plate; these, however, are wanting on the outer part of the ray, and there is no definite line of spinelets on the aboral side of the plate. The surface of the plate is covered with short papilliform spinelets rather than squamules, which become longer, more delicate, and very numerous in the furrows.

The armature of the adambulacral plates consists of delicate spines, of moderate length, all cylindrical, and only slightly tapering, which form three regular series, with three spinelets in each. The spines of the inner or furrow series radiate well apart, and the middle one is the longest. The spinelets of the second series are all equal in length, and slightly shorter than the inner series, and are frequently placed in a somewhat oblique line. The spines of the outer series are, perhaps, a trifle smaller than the second series, and do not always stand in a regular line; sometimes an additional spinelet is present, and sometimes only two.

The actinal intermediate plates are numerous, twenty to thirty being present in the interradial area, each bearing about eight to ten short, delicate spinelets, rather widely spaced, and radiating apart, which gives an appearance suggestive of paxillæ; and most of the plates, excepting the inner series, have a long and more robust spinelet springing from the midst.

The mouth-plates, which are rather short and small, are covered with numerous closely

placed spinelets. A double line is present on the surface of the plate, those near the middle line of the mouth-angle being large, robust, compressed transversely, and with tips obtusely rounded, and increasing in size towards the inner extremity of the plate. The innermost spines of the mouth-angle form a short horizontal comb of four parallel spines directed towards the centre of the mouth. The margins of the mouth-plates are fringed with a line of about eight small ciliary spines, which decrease in size and robustness as they recede from the mouth.

The madreporiform body, which is small, slightly convex, and with fine striations, is placed at about its own breadth distant from the marginal plates.

The ambulacral tube-feet are pointed, and the extreme tip appears to be very slightly thickened.

The terminal (ocular) plate is elongate, and armed at the extremity with four or five short, robust spinelets directed outward.

Colour in alcohol, brownish grey.

Locality.—Off Inaccessible Island, Tristan da Cunha. Depth 90 fathoms.

Remarks.—This species is in many respects a very abnormal *Astropecten*. So far as general formula is concerned its nearest ally in that genus is *Astropecten pentacanthus*, Delle Chiaje, sp., but the facies of the two forms is altogether different, and they could not possibly be mistaken. The character of the abactinal paxillæ (the pedicle being represented only by a broad tubercular eminence of the plate) and the great development of the actinal interradial areas are altogether unlike any *Astropecten* with which I am acquainted. It is not without hesitation that I have admitted the form into the genus.

Two specimens of *Astropecten* obtained by the "Gazelle" near the eastern coast of South America (off Buenos Ayres) in lat. 34° 43′ 7″ S., long. 52° 36′ 1″ W., at a depth of 44 fathoms, have been referred by Professor Th. Studer[1] to this species.

Genus *Psilaster*, Sladen.

Psilaster, Sladen in Narr. Chall. Exp., 1885, vol. i. p. 611.

Disk small. Rays moderately long, robust and high at the base, tapering to a pointed extremity.

Marginal plates plane or slightly tumid, not forming a ridge or highly developed fasciolar groove. The surface of the plates is covered with small papilliform squamules or granules. The supero-marginal plates are devoid of large spines or tubercles. The infero-marginal plates may bear several small spinelets, appressed to the ray, disposed in series near the lateral margin and usually near the aboral edge of the plate.

Abactinal area with compact paxillæ, composed of short papilliform spinelets, and arranged usually in regular transverse lines at the sides of the ray.

[1] *Anhang z. d. Abhandl. d. k. preuss. Akad. d. Wiss. Berlin*, vom Jahre 1884, p. 46.

Actinal interradial areas small, with numerous small intermediate plates which extend far along the ray. The intermediate plates all bear small compact groups of spinelets.

Armature of the adambulacral plates consisting of:—(1.) a furrow series of rather long, delicate, cylindrical, uniform spinelets, which form either a straight series or may be slightly curved. (2.) On the actinal surface of the plate are two longitudinal series of shorter and more compressed spines, the inner of these two series being frequently irregular.

Madreporiform body large and situated rather nearer the margin than midway between it and the centre of the disk.

No true pedicellariæ are present, but an incipient form of the organ may occur in some species.

Remarks.—The type of this genus is the starfish originally described by Müller and Troschel[1] under the name of *Astropecten andromeda*. It appears to me to merit generic distinction on account of the difference (1.) in the character of the marginal plates, (2.) in the number and disposition of the actinal intermediate plates, (3.) in the armature of the adambulacral plates, (4.) in the spinulation of the marginal plates, and (5.) in the character of the paxillæ.

Synopsis of the Species included in the Genus Psilaster *herein described.*

A. With marginal plates vertical, almost confined to the lateral wall of the ray.
  a. With narrow delicate rays. Interbrachial arcs well rounded. With papilliform granules on the marginal plates: no membrane. Inner pair of mouth-spines very large . . . . . *gracilis.*
  b. With robust rays, thick at the base. Interbrachial arcs acutely rounded. With squamiform papillæ on the marginal plates, often covered with membrane. Inner pair of mouth-spines small.
    a. Infero-marginal plates at the base of the ray with four or five flattened spinelets equally spaced on the aboral margin. Inner pair of mouth-spines subequal to the rest. Supero-marginal plates conspicuously encroaching on the abactinal area on the outer part of the ray . *andromeda.*
    b. Infero-marginal plates at the base of the ray with three or four small flattened spinelets grouped in a slightly oblique series near the aboral end of the lateral margin. Inner pair of mouth-spines conspicuously longer than the rest. Supero-marginal plates not conspicuously encroaching on the abactinal area on the outer part of the ray . *acuminatus.*

B. With broad marginal plates, forming a broad, conspicuous margin to the abactinal area.
  a. With marginal plates nearly plane. Supero-marginal plates with no specially enlarged tubercle. Infero-marginal plates with one spine near the lateral margin. No pedicellariæ on the marginal plates . . . . . *cassiope.*
  b. With marginal plates distinctly tumid. Supero-marginal plates often with a specially enlarged tubercle. Infero-marginal plates with an oblique series of four spines near the lateral margin. Incipient pedicellariæ on the marginal plates. *patagiatus.*

[1] System der Asteriden, 1842, p. 129.

Chorology of the Genus Psilaster.

α. Geographical distribution:—

Atlantic: Four species between the parallels of 75° N. and 40° S.

Psilaster andromeda, off the Scandinavian coasts, and off the British Islands, extending to the Bay of Biscay. *Psilaster cassiope* and *Psilaster patagiatus*, off the Cape Verde Islands. *Psilaster acuminatus* occurs in the extreme South Atlantic, in Simon's Bay, Cape of Good Hope.

Pacific: Two species between the parallels of 40° N. and 50° S.

Psilaster gracilis, off Japan. *Psilaster acuminatus*, off Australia and New Zealand.

β. Bathymetrical range: Shallow water to 1875 fathoms.

Four species, viz., *Psilaster cassiope*, *Psilaster patagiatus*, *Psilaster andromeda*, and *Psilaster acuminatus* are found in the Littoral zone; and the two last named pass through the Continental zone and extend into the Abyssal zone. *Psilaster gracilis* is confined to the Abyssal zone.

Greatest range of one species: *Psilaster acuminatus*, shallow water to 950 fathoms.

γ. Nature of the Sea-bottom: Two species, *Psilaster acuminatus* and *Psilaster gracilis*, are found on Blue mud, the former also occurring on Green mud in 950 fathoms. *Psilaster andromeda* inhabits a clay bottom, sometimes sandy.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Psilaster acuminatus	South Atlantic.	Shallow.	.....
	South Pacific.	150 to 950	Green mud (950 fathoms). Blue mud (150 fathoms).
Psilaster andromeda	North Atlantic.	40 to 690	Clay, sometimes sandy.
Psilaster cassiope	Atlantic.	...	.....
Psilaster gracilis	Pacific.	1875	Blue mud.
Psilaster patagiatus	Atlantic.	...	.....

1. *Psilaster andromeda*, Müller and Troschel, sp.

Asterias aranciata (*varietas*), Parelius, 1768, K. Norske Vidensk. Selskabs Skrifter, vol. iv. p. 426, tab. xiv. figs. 5, 6.
Astropecten Andromeda, Müller and Troschel, 1842, System der Asteriden, p. 129.
Astropecten Christi, Düben and Koren, 1844, Öfvers. k. Svensk. Vet.-Akad. Förhandl., p. 113.
Archaster Andromeda, Möbius and Bütschli, 1875, Jahresb. d. Comm. z. wiss. Untersuch. d. deutsch. Meere in Kiel, f. d. Jahre 1872–73; ii. iii. Jahresb., iv. Echin., p. 148.
Archaster Christi, Perrier, 1876, Révis. Stell. Mus., p. 347 (Archives de Zool. expér., t. v. p. 267).
Goniopecten chisti, Perrier, 1885, Ann. Sci. Nat. Zool., t. xix., Art. No. 8, p. 71 (*err. typ.*).

Localities.—"Porcupine" Expedition:

Station 76, 1869.[1] West of the Shetland Islands. Lat. 60° 36′ N., long. 3° 58′ W. Depth 344 fathoms. Bottom temperature −1°·1 C.; surface temperature 10°·1 C.

Station 3, 1870.[1] West of Ushant, south-west of the Scilly Islands. Lat. 48° 31′ N., long. 10° 3′ W. Depth 690 fathoms.

"Knight Errant" Expedition:

Station 7. August 12, 1880. Lat. 59° 37′ N., long. 7° 19′ W. Depth 530 fathoms.

"Triton" Expedition:

Station 10. August 24, 1882. Lat. 59° 40′ N., long. 7° 21′ W. Depth 516 fathoms. Bottom temperature 46° Fahr.

Station 11. August 28, 1882. Lat. 59° 29′ N., long. 7° 13′ W. Depth 555 fathoms. Bottom temperature 45°·5 Fahr.

Remarks.—The structure of this form, as indicated in the foregoing generic diagnosis, fully warrants in my opinion its separation from *Astropecten;* and I have already drawn attention in the remarks following the generic diagnosis, to the prominent characters wherein this species differs from any true member of the genus *Astropecten*.

Müller and Troschel[2] described this species as sometimes furnished with small spinelets on the supero-marginal plates, but I have not noticed their presence in any specimens I have examined. In this respect I can confirm the observations of Sars,[3] and Danielssen and Koren,[4] and also the description given by Düben and Koren.[5] In the "Knight Errant" specimen all the spinulous or papilliform appendages of the actinal surface are invested with a thick membranous tissue which is often more or less united at their bases, and in some parts coalescent even at their extremities, which are joined by web-like and fibrillar extensions. The appearance thus produced is accurately enough expressed by Düben and Koren's "gelatinöst öfverdrag;"[6] and I have no doubt whatever as to the correctness of their description in this respect, although the

[1] These occurrences are recorded in Sir Wyville Thomson's Depths of the Sea, but I have not seen any specimens.
[2] System der Asteriden, p. 129.
[3] Oversigt af Norges Echinodermer, p. 30.
[4] *Nyt Mag. f. Naturvidensk.*, 1877, Bd. xxiii. 3, p. 66.
[5] *K. Svensk. Vetensk.-Akad. Handl.* År 1844 (1846), p. 250.
[6] *Loc. cit.*, p. 251.

character referred to has subsequently been called in question. Sars[1] states definitely that it did not occur in any of his specimens, and he considered that Düben and Koren had been deceived by the presence of foreign matter. Düben and Koren remark that the character is not a constant one.

A large series of specimens shows a considerable amount of variation in the relative breadth of the supero-marginal plates and the paxillar area upon the rays. In examples from Drøbach the supero-marginal plates as a rule arch over very slightly upon the actinal surface. On the other hand, in a specimen from Tromsö in the Christiania Museum they are very wide. This example is also noteworthy on account of the different character of the paxillæ, which are more rounded in form, and with the component spinelets radiating more apart; whereas in the usual type the spinelets are pressed together and directed upward, and the crown is more or less pentagonal in form. The spinelets on the aboral margin of the infero-marginal plates of the Tromsö specimen are very insignificant, and are almost aborted into robust squamules. The armature of the adambulacral and actinal intermediate plates, which is papilliform, uniform, and invested with membrane, has a very distinct appearance, as well as the almost naked and flatly appressed covering of the infero-marginal plates. In the Drøbach specimens the three or four spines on the infero-marginal plates are well developed.

I have also seen a specimen from Lofoten with broad supero-marginal plates and well-developed spines on the infero-marginal plates, which are rather wide apart and uniform.

A number of the specimens in the Stockholm collection have the supero-marginal plates arching well upon the abactinal surface, but in an example from Bohuslän the arching is very slight.

To a certain extent the supero-marginal plates appear to be relatively broader in young forms, and narrower and less arching in the larger examples.

The most interesting variety I have seen is one in Christiania determined by M. Sars, which bears a ticket inscribed by him, "Varietet med bredere Paxillarfeldt paa Armene og mindre brede dorsale Randplader. Paa 200 Favnes Dyb paa Line. Fensfjorden." In this example the supero-marginal plates are very narrow and almost perpendicular. The spines on the infero-marginal plates (a series of three to five) are long and thin, the third from the margin being longest. The central part of the plate is naked. Similarly the supero-marginal plates have only a few granules on the upper part and near the margins of the plate.

Sars[1] has remarked that the northern examples of this species seem to have generally shorter arms than the southern ones.

2. *Psilaster acuminatus*, n. sp. (Pl. XL. figs. 1 and 2; Pl. XLII. figs. 7 and 8).

Rays five. R = 65 mm.; r = 15 mm. R = 4·3 r. Breadth of a ray at the base, 14·5 mm.

[1] Oversigt af Norges Echinodermer, Christiania, 1861, p. 31.

Rays elongate, very narrow on the outer portion, moderately broad at the base, and tapering continuously therefrom to the extremity, which is fine and pointed. Interbrachial arcs acute, but rounded.

The abactinal paxillar area is very uniform and compact in character, the paxillæ diminishing in size towards the centre of the disk and the extremities of the rays. The paxillæ consist of three to six central granules, surrounded by about a dozen short papilliform spinelets on the margin of the tabulum. The paxillæ are arranged in regular transverse lines at the sides of the ray, whilst the median line is narrow and with the paxillæ slightly larger and irregular in their arrangement. In some examples a slight prominence occurs in the centre of the disk.

The supero-marginal plates, about 40 in number from the median interradial line to the extremity, are comparatively flat, and higher than broad, their surface forming an arched bevel to the ray rather than a tumid rounding. Flat squamiform granules are present on the upper part of the plate, but are wanting on the lower part, which is covered with membrane. No spines or tubercles of any description are present on the supero-marginal plates.

The infero-marginal plates are higher than broad, and form a gentle and well-rounded curve on the actinal surface. In consequence of the form of the plates, nearly the whole height of the supero-marginal and infero-marginal plates can be seen when the side of the ray is placed in direct line of view. Each infero-marginal plate bears three small, straight, flattened, tapering and sharply-pointed spinelets arranged close together in an oblique line close to the lateral margin and the aboral edge of the plate. The upper spinelet, which is nearest the margin, is the smallest, and the other two are about equal in length. All are directed slightly outward in the direction of the ray, and being closely appressed to the side of the ray are almost invisible when seen from above. On the inner half of the ray a fourth spine is present a little way behind the foregoing on the aboral side of the plate, and on the innermost plates of all a fifth may also occur. The infero-marginal plates have a number of small, closely placed, papilliform squamules on the end adjacent to the adambulacral plates, but the rest of the plate is covered with membrane.

The armature of the adambulacral plates consists of an inner or furrow series of five or six nearly equal and delicate spinelets, slightly clavate, cylindrical or subcompressed, which form a very slightly radiating fan. The second series usually consists of three spinelets, shorter and more compressed than the inner series, and with truncate tips ; and the third series of three or four similar spines. Irregularity frequently occurs in the arrangement of the second series.

External to the adambulacral plate is a small intermediate plate, the series of which extends far along the ray ; these bear a compact group of six to eight spinelets, similar in every respect to the outer series of adambulacral spinelets, and from which they are indistinguishable on the outer part of the ray, forming together a common group. The

interradial area is occupied by numerous small intermediate or ventral plates, all of which bear groups of spinelets similar to those above mentioned; and most of the plates in a large specimen have a single flattened and pointed spinelet springing from the midst.

The mouth-plates are elongate and ovoid, prominent, with a regular and conspicuous armature, consisting of a single line of short, robust, papilliform spinelets, slightly flattened and with rounded tops, arranged along the outer margin of the surface of the plate. The space between the companion series of a mouth-angle is wide and elliptical in outline. On the free side of the plate, and at a higher level, is a secondary series of small mouth-spines, closely apposed to the bases of the superficial series, which fit into the interspaces, and are almost invisible when viewed from above. The innermost mouth-spines are considerably longer than the papilliform superficial armature, and form a small fan of four parallel spinelets at each mouth-angle, the outside spinelet at each side being shorter than the others.

The madreporiform body is small, and situated rather nearer the margin than midway between it and the centre of the disk.

Colour in alcohol, yellowish grey, with traces of a darker grey tint remaining here and there on the paxillar area.

Locational Variation.—Two examples from Simon's Bay are of much larger size than any of those which I have considered to be the type-form, and they are characterised by the presence of a small appressed spine on the supero-marginal plates on the lateral wall of the ray, near the rounding of the plate, and similar to the spines on the infero-marginal plates. The spinelet is wanting on a few plates in the interbrachial arc, and at the extremity of the ray.

In a still larger specimen from Station 164, off Sydney, the rays are much broader and flatter in appearance than in the examples above mentioned, and the supero-marginal plates extend further on the abactinal surface, forming a comparatively broad border when seen from above; and the single, delicate, appressed spine borne on the supero-marginal plates is even more elongate and conspicuous than in the specimens from Simon's Bay.

It is interesting to note that the South African form is distinctly intermediate in size and character between the New-Zealand and the Australian forms. Although the differences in appearance between the two latter are very striking when viewed by themselves, I do not feel warranted under the circumstances, and with such a small supply of material at command, in marking any of these distinctions by name. When more specimens are available, such a course may be found desirable.

Localities.—Station 167. North-west of Port Hardy, New Zealand. June 24, 1874. Lat. 39° 32′ 0″ S., long. 171° 48′ 0″ E. Depth 150 fathoms. Blue mud. Surface temperature 58°·5 Fahr.

Station 164. South-east of Sydney. June 12, 1874. Lat. 34° 8′ 0″ S., long. 152° 0′ 0″ E. Depth 950 fathoms. Green mud. Bottom temperature 36°·5 Fahr.; surface temperature 69°·5 Fahr.

Simon's Bay, Cape of Good Hope. (Depth and conditions not recorded.)

Remarks.—This form is very nearly allied to the North-Atlantic species *Psilaster andromeda*. It may be distinguished by the infero-marginal plates at the base of the ray having three or four small flattened spinelets grouped in a slightly oblique series near the aboral end of the lateral margin; by the inner pair of mouth-spines being conspicuously larger than the rest; and by the supero-marginal plates not encroaching conspicuously on the abactinal area on the outer part of the ray.

3. *Psilaster cassiope*, n. sp. (Pl. XLI. figs. 1 and 2; Pl. VII. figs. 9 and 10).

Rays five. R = 63 mm.; r = 16·5 mm. R < 4 r. Breadth of a ray near the base (between the third and fourth supero-marginal plates), 14·5 mm.

Rays elongate and tapering; attenuate towards the extremity but with the breadth diminishing very slightly along the inner half of the ray. Lateral walls rather high, well and equally rounded towards the abactinal and actinal surfaces, but nearly straight and vertical between these curves. Abactinal and actinal areas subplane, giving the rays a more or less depressed conico-cylindrical form. Interbrachial arcs acutely but distinctly rounded.

The abactinal paxillar area of the disk and rays is covered with numerous small and closely crowded paxillæ. These are low and of uniform height throughout, and the larger ones consist of ten to sixteen very short, thick, papilliform spinelets, with one to three irregularly central, the whole forming a compact group, and looking more like rounded granules than papillæ. Excepting upon the central area of the disk, and along a narrow band-like strip in the median dorsal line of the rays, the paxillæ are arranged in very distinct and conspicuous transverse series, each series distinctly spaced from its neighbours, and with the paxillæ slightly elongate in the direction of the axis of the ray. The paxillæ diminish slightly in size as they approach the margin, and also in the central area of the disk.

The supero-marginal plates, thirty in number from the median interradial line to the extremity, form a broad and conspicuous border to the disk and rays. Midway along the ray the breadth is subequal to that of the intermediate paxillar area, and the latter contracts continuously up to the extremity; the area is also at a slightly lower level than the marginal plates, and this, together with the well-rounded curvature of the latter, gives an emphatic character to the border. Except on the inner part of the ray the breadth is greater than the height, and is considerably greater than the length throughout. The abactinal and lateral planes of the plate are united by a full and well-rounded semicircular curve. The two or three plates in the midst of the interbrachial arc are shorter and less tumid in their curvature than the succeeding plates. The surface of the plates is covered with rather large distinctly spaced granules, which become smaller, more crowded, and

papilliform along the transverse margins, thus emphasising the suture. No spines are borne on the supero-marginal plates.

The infero-marginal plates correspond to the superior series, and their breadth is greater than either the height or the length; their surface is covered with granules apparently similar to those above described and of equal size, but which have a tendency to become scutiform as they approach the end of the plate adjacent to the adambulacral plates. Their length and posture is such that they have quite the appearance of granules, and their squamous character is only made out after careful examination. Each infero-marginal plate bears normally a single small spinelet, which is short, tapering, slightly compressed, and appressed to the side of the ray. It is situated at the extreme margin of the ray, on the rounding which unites the actinal and lateral areas of the plate, and stands close to the aboral margin of the plate. On two or three of the plates in the interbrachial arc a second and similar spine may be present, placed midway between the lateral spine and the inner end of the plate; and in very rare instances there may be one or even two small spines above the lateral spine, between it and the abactinal end of the plate, these spines being always at the aboral margin of the plate.

The adambulacral plates are large, with a prominent angular margin towards the furrow. Their armature consists of an inner or furrow series of seven or eight short, delicate, cylindrical, equal spinelets, encased in membrane, but apparently without any saccular developments. On the actinal surface of the plate are one or two longitudinal series of three or four equal spines, slightly shorter than the inner series. There is frequently, however, irregularity in the disposition of these spinelets; and the whole armature usually forms a wedge-shaped group, the arrangement of which is difficult to formulate.

The mouth-plates are elongate and very narrow; their armature consists of a marginal series of sixteen to eighteen short, cylindrical, obtusely rounded or subclavate papillæ on each plate, which increase slightly in length as they approach the anterior end. The two innermost are longer and much more robust than the rest. On the actinal surface of the plate is a single uniserial row of low, broad, round-topped and slightly compressed papillæ, about sixteen or eighteen in each series. These stand vertical, and the marginal series are closely appressed to their sides.

The actinal intermediate plates, though confined to a very small area in the interradial region, extend far along the ray. Those near the adambulacral plates bear spinelets which are indistinguishable from the adambulacral armature, whilst those near the marginal plates, in the interradial area at least, become somewhat more papilliform, and though maintaining a strictly spinulate character, approach in a certain degree the squamulate form of the covering of the marginal plates. All these spinelets are covered with thin membrane, which has to some extent the peculiar fibrillar or matted character sometimes noticed in the Northern form, and many of the spinelets have the same agglomerated appearance suggestive of entangled foreign matter or tissue.

The madreporiform body is small, and but little more than its own diameter distant from the inner edge of the marginal plates. It is slightly below the level of the general paxillar area; and its surface is grooved by rather coarse but deep striation furrows.

Colour in alcohol, a bleached yellowish white, with a deeper shade, verging on light brown, on the paxillar area.

Locality.—Off the Cape Verde Islands. (Depth and conditions not recorded.)

Remarks.—This species is unquestionably allied to *Psilaster andromeda* and *Psilaster acuminatus*, but is at once distinguished by the much greater breadth of the supero-marginal plates; by the comparative smallness and regularity of the abactinal paxillæ; by the single spine on the infero-marginal plates; and by the character of the granulation of the marginal plates generally.

4. *Psilaster gracilis*, n. sp. (Pl. XLI. figs. 5 and 6; Pl. XLII. figs. 9–11).

Rays five. R = 65 mm., $r = 12$ mm. $R < 5{\cdot}5\,r$. Breadth of the ray at the third supero-marginal plate, 11·5 mm.

Rays elongate, narrow and tapering throughout to a finely pointed extremity, having a subcylindrical facies, slightly compressed. Abactinal area slightly convex and capable of inflation. Actinal area subplane. Lateral walls comparatively high and vertical. Interbrachial arcs open and widely rounded.

The abactinal paxillar area of the disk and rays is covered with comparatively large and closely placed paxillæ. These are composed of very short, stumpy, papilliform spinelets. Three to five are central, more robust than the rest, often almost granuliform, and about a dozen or more form the marginal series, all very short and radiating outward. In some of the paxillæ the central spinelets are posed in such a way as to form incipient pedicellariæ, in others three or four of the central spinelets are slightly longer, and are distinctly pedicellarian in function. At the margin of the area an arrangement of the paxillæ in transverse series may be observed, but is not very conspicuous at first sight, on account of the crowding of the paxillæ, and is only well seen near the base of the rays.

The supero-marginal plates, thirty-six in number from the median interradial line to the extremity, stand vertically, and, being confined entirely to the lateral wall of the ray, can hardly be said to have a distinct breadth on the abactinal area, excepting on the outer part of the ray, as they merge so gradually into the rounding of the lateral wall. On the outer part, however, they are more distinctly curved over and flattened on the abactinal area. The surface of the plates in relation to one another forms a continuous plane. On the inner part of the ray the height is about one-third greater than the length, and further outward than midway along the ray the dimensions are nearly subequal. The surface of the plates is closely covered with short obtusely tipped papillæ, equal in length but slightly more robust along the median region of the plate; and all so closely placed

as to give the appearance of coarse velvet pile. The supero-marginal plates bear no spinelets.

The infero-marginal plates correspond to the superior series, each plate being equal in length to its companion in the upper series. Their height, however, is slightly less, and they are well curved upon the actinal surface. Their surface is covered with short close-set papillæ similar to those on the supero-marginal plates, which become slightly larger and more spiniform at the end of the plate adjacent to the adambulacral plates. Each plate bears along the upper half of the aboral margin a series of four (normally, but sometimes three) small tapering spinelets. The uppermost spine is the smallest, the rest subequal or with either the lowest or the median spine slightly longest. They are closely appressed to the side of the ray, and are directed at a slight angle upward: the position of the series on the plate being also sometimes very slightly oblique.

The adambulacral plates are elongate, large, with a faintly convex margin towards the furrow. Their armature consists of a furrow series of six or seven rather long, delicate, cylindrical spinelets, equal in length, covered with membrane, and standing parallel to one another. The series or "combs" thus formed are distinctly spaced from the neighbouring series on adjacent plates. On the actinal surface of the plate and near to the marginal series is a longitudinal series of three or four spines, slightly shorter and more robust, widely and irregularly spaced; and external to these is another longitudinal series of four or five similar spines, but even more irregular in disposition: indeed, so far is this carried in both cases that it is often impossible to distinguish any regular serial arrangement at all. Sometimes a few additional spinelets may be present, external to those above mentioned, and the grouped character becomes then more marked. These spinelets on the actinal surface of the adambulacral plate are covered with membrane like the marginal series, and they have generally a more or less straggling and irregular appearance.

The mouth-plates are elongate and narrow, and the united pair form a convex keel actinally. Their armature consists of a marginal series of small, rather robust, and abruptly tapering spinelets, shorter than the marginal series on the adambulacral plates, about six or seven on the free margin of the plate, although others appear to continue the series up to the outer extremity of the plate. At the innermost point of each mouth-plate is one elongate, flattened and round-tipped mouth-spine, greatly exceeding any of the other spines in size, and the pair of spines at each mouth-angle are parallel to one another and directed towards the centre of the actinostome. At first sight these enlarged spines might be considered as the innermost spines of the marginal series above described, but I am doubtful whether this is really the case, as there is the singular occurrence in this form of a small group of short spinelets present on each plate at a still higher level than the foremost mouth-spines above mentioned, and this little insignificant group is further peculiar from the fact that it is not directed towards the centre of the actinostome, but in the direction of a line crossing the ambulacral furrow. If this group of small and abnor-

mally placed spinelets really belongs to the true marginal series it is probable that the prominent and enlarged mouth-spine should be reckoned as the foremost of the actinal or superficial series. On the actinal surface of each plate is a longitudinal series of eight to twelve rather robust and conically pointed spinelets, parallel to the median suture; and an intermediate series, fewer in number and more widely spaced, between these and the marginal series.

The actinal intermediate plates are confined to a very small area in the interradial region, but I am unable to say from superficial observation whether their arrangement presents any regularity or not. Each of the plates bears two or three short, robust, conical tipped spinelets, which have a more or less marked tendency to form a group.

The madreporiform body is entirely obscured by paxillæ.

Colour in alcohol, a dirty greyish white.

Locality.—Station 237. Off the coast of Japan, south of Kawatsu. June 17, 1875. Lat. 34° 37′ 0″ N., long. 140° 32′ 0″ E. Depth 1875 fathoms. Blue mud. Bottom temperature 35°·3 Fahr.; surface temperature 73°·0 Fahr.

Remarks.—Psilaster gracilis has a very different facies from any of the other species described, and it is not without hesitation that I have included it in the genus. It is at once distinguished by its narrow subcylindrical rays and widely rounded interbrachial arcs; by the papilliform covering of the marginal plates; by the large inner pair of mouth-spines; and by the general character of the actinal spinulation.

5. *Psilaster patagiatus*, n. sp. (Pl. XLI. figs. 3 and 4; Pl. VII. figs. 11 and 12).

Rays five. R = 79 mm.; r = 20 mm. $R < 4r$. Breadth of a ray near the base (between the second and third supero-marginal plates), 19·5 mm.

Rays elongate, broad at the base, and tapering continuously and gradually up to the extremity. General form comparatively flat and depressed. Abactinal and actinal areas subplane. Interbrachial arcs widely open and rounded.

The abactinal paxillar area of the disk and rays is covered with numerous, rather large, distinctly spaced paxillæ. These are composed of very small, short, delicate, cylindrical spinelets, three to five or rarely more being central, and surrounded by a marginal circle of about a dozen; the latter, instead of radiating outward as usual in paxillæ, have a slight inclination inward, which gives the groups a more or less closed and highly characteristic appearance. By this means the papulæ, which are remarkably small, are all exposed to view. In some of the paxillæ three or four of the central spinelets are slightly enlarged, and appear to form a pedicellarian organ. Along the margin of the area the paxillæ are arranged in very regular transverse series; but there is no definite order along the median radial line or in the central area of the disk.

The supero-marginal plates, thirty in number from the median interradial line to the

extremity, form a broad and conspicuous margin to the disk and rays. Each plate is slightly tumid; and midway along the ray their breadth is greater than that of the paxillar area, the latter contracting outwardly into a mere narrow strip. The length of the plates is about two-thirds of their breadth, and their height is about one-half the breadth. The abactinal and lateral areas of the plate are united by a well-rounded curve: the tumidity above mentioned being conspicuous there. The surface of the plates is covered with low, robust, granuliform papillæ, which become small and crowded in the regions of the transverse margins, there being a great disparity in size between these and the robust granule-like papillæ along the median line of the plate. This disparity, however, may vary in degree; and sometimes one or more of the papillæ on the tumidity or rounding are larger than the rest, and even simulate a small supero-marginal tubercle or low conical spinelet. The majority of the supero-marginal plates bear one or even two pedicellariæ of simple formation, but each in relation with a pit in the plate, and frequently simulating very suggestively some of the foraminal or "excavate" forms of the organ found in the Pentagonasteridæ and allied families.

The infero-marginal plates correspond exactly to the superior series, and their breadth on the actinal area is as great as that of the superior series on the abactinal area. Their surface is covered with papillæ, which become large, flattened, and squamiform in the median region of the plate towards the end adjacent to the adambulacral plates. Each plate bears at the upper end on the aboral margin a slightly oblique row of three small, delicate, cylindrical, tapering spinelets, standing close together, subequal, rather longer than the plate, and appressed to the side of the ray. On the inner half of the ray there is frequently one or even two similar spinelets on the aboral margin of the plate between this series and the end of the plate adjacent to the adambulacral plates, but always widely separate. Sometimes four spinelets are present in the oblique lateral series, the uppermost being rather smaller than the others.

The adambulacral plates are large and massive, rather longer than broad, and with a slightly convex margin towards the furrow. Their armature consists of a furrow series of ten long, thin, very delicate, cylindrical spinelets, subequal in length, which is about equal to that of the plate, and standing subparallel. In a large example these spinelets are slightly compressed laterally, and all are covered with a very thin membrane. On the actinal surface of the plate are about three irregular longitudinal rows of spinelets, with five or six in each, which are short, tapering, pointed, and covered with membrane, the whole forming a group rather than regular series. The length of the spinelets on the actinal surface of the plate is much shorter than that of the furrow series, and diminishes as the spinelets recede from the furrow.

The mouth-plates are elongate and narrow, and the united pair are subelliptical and prominent actinally. Their armature consists of a marginal series of very small, short, tapering, and rather widely spaced spinelets, which are closely appressed to the superficial

series ; the innermost spine on each plate is greatly enlarged, and forms with its companion a robust pair directed horizontally inward at each mouth-angle. On the actinal surface of each plate are two longitudinal series of short, stumpy papillæ, the innermost two or three rather more elongate than the rest, and all covered with membrane.

The actinal intermediate plates are confined to a small area in the interradial region, where they are arranged in regular columns or series parallel to the median interradial line ; and they do not extend along the ray further than the ninth adambulacral plate, or the fifth infero-marginal plate. They bear a number of short skin-covered spinelets, similar to those on the actinal surface of the adambulacral plates, and, as these are more or less grouped together, the separate plates remain distinguishable.

The madreporiform body is very small, situated about midway between the margin and the centre of the disk. Its surface is grooved by comparatively few coarse striation furrows, and in the central region of its surface there is a tendency towards the development of a few isolated granules upon the intervening dissepiments.

Colour in alcohol, a bleached yellowish white.

Locality.—Off the Cape Verde Islands. (Depth and conditions not recorded.)

Remarks.—This is a very abnormal Astropectinid, and I feel great doubts as to the correctness of referring it to the genus *Psilaster*. The form presents several points of affinity to the Archasteridæ, but I am unable to include it in any of the genera belonging to that family. Under the circumstances I consider it better to refrain from constituting a new genus for the reception of this single species until more is known of its structure.

The species cannot be mistaken for any of the other forms of *Psilaster;* the broad and distinctly tumid marginal plates, the presence of the incipient pedicellariæ, the character of the paxillæ, and the armature of the infero-marginal plates readily distinguish it.

Genus *Phoxaster*, Sladen.

Phoxaster, Sladen in Narr. Chall. Exp., 1885, vol. i. p. 611.

Disk small. Rays moderately elongate, robust and tapering. Lateral walls high and nearly vertical.

Marginal plates short and high, confined to the lateral wall. Superior and inferior series correspondent. The surface of both series of plates is covered with short, uniform, flat-lying squamiform papillæ. No large or prominent spines are normally present.

Abactinal area with small compact paxillæ, composed of short skin-covered papillæ, which fit together subprismatically. A small but prominent and well-defined conical epiproctal protuberance is present in the centre of the disk.

Actinal interradial areas small in the interbrachial region, but a series of narrow band-like plates extends along the ray, nearly to the extremity, separating the adambulacral

from the infero-marginal plates. All these actinal intermediate plates bear uniform squamule-like papillæ invested with membranous sacs.

Adambulacral plates large and pentagonal in shape. Armature consisting of:—(1.) An angulated furrow series of five short, subequal, papilliform spinelets, the median one being triangular in section. (2.) On the actinal surface two longitudinal series of short, flattened spinelets, the inner series often disposed in such a manner as to close against the furrow series, thus forming perhaps an incipient pedicellarian apparatus. All the spinelets are in membranous sheaths.

Madreporiform body small, oval, and situated about its own diameter distant from the margin of the paxillar area.

No pedicellariæ are present.

Remarks.—This genus is distinguished from *Bathybiaster* by the presence of the epiproctal cone, and by the absence of the pedicellariæ which specially characterise the latter form.

The genus *Ilyaster*, established by Danielssen and Koren [1] for the reception of a small Asterid furnished with a remarkably developed epiproctal prolongation, dredged during the Norwegian North Atlantic Expedition, is probably more nearly related to this genus than to any other form with which we are acquainted. So far as I am able to judge from the description and figures alone, the position of *Ilyaster* in the tabular scheme of the family would probably be adjacent to *Phoxaster*, and perhaps intermediate between that genus and *Bathybiaster*. It differs from *Phoxaster* by the extraordinary development of the "dorsal appendage" and by the character of the armature of the adambulacral plates; furthermore, as no mention is made in the careful description given by its authors of any special membranous investment of the general tegumentary spinulation or granulation, *Ilyaster* probably differs in that respect also.

Respecting the dorsal appendage, it may be remarked that the difference in the relative size of that structure in *Ilyaster* and *Phoxaster* is not greater than that existing between different species belonging to the genus *Porcellanaster;* for instance, between *Porcellanaster cæruleus* and *Porcellanaster caulifer*. The structure of the prolongation, however, would appear to be much more specialised in *Ilyaster* than in *Phoxaster*. I fully share with the learned describers of *Ilyaster* their doubt as to its being an adult form.

I have on a preceding page (pp. 131, 132) stated my opinion that this elongate epiproctal prolongation is in no way homologous to the stem of a Crinoid, as maintained by Drs Danielssen and Koren.[2]

[1] *Nyt Mag. f. Naturvidensk.*, Bd. xxviii. 1ste Hefte, p. 4, tab. i. ii. figs. 15–19; Den Norske Nordhavs-Expedition, 1876–78, Zoologi, xi. Asteroidea, 1884, p. 100, tab. vii. figs. 15–19.

[2] *Loc. cit.*, pp. 102, 103.

Chorology of the Genus Phoxaster.

α. Geographical distribution :—

Atlantic : One species between the parallels of 35° and 45° N.

Phoxaster pumilus off the eastern coast of the United States of North America.

β. Bathymetrical range: 1240 to 1700 fathoms. The form is thus confined to the Abyssal zone.

γ. Nature of the Sea-bottom: Blue mud.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Phoxaster pumilus . . .	Atlantic.	1240 to 1700	Blue mud.

1. *Phoxaster pumilus*, n. sp. (Pl. XL. figs. 3–6 ; Pl. XV. figs. 7–11).

Rays five. R = 31 mm. ; $r = 7{\cdot}5$ mm. $R > 4\,r$. Breadth of a ray at the third supero-marginal plate, 7 mm.

Rays moderately elongate and robust, tapering from the base to the extremity, which is rather abruptly pointed. Lateral walls high and nearly vertical. Abactinal area subplane, with a prominent and well-defined, though small, epiproctal protuberance. Actinal area merging into the rounding of the lateral wall. Interbrachial arcs acutely rounded.

The abactinal paxillar area of the disk and rays is covered with numerous small, compact paxillæ. These are composed of four to seven short, equal, truncate, granuliform, skin-covered papillæ, which fit close together subprismatically, with one often central in the larger paxillæ, but by no means invariably. The paxillæ diminish in size as they approach the centre of the disk, and become almost indistinguishable on the central peak-like protuberance. A more or less regular arrangement in transverse series may be distinguished at the margin along the inner half of the rays, the successive series being more widely spaced than the paxillæ in each series.

The supero-marginal plates, forty in number from the median interradial line to the extremity, are very short and high, standing vertically, and confined entirely to the lateral wall of the ray, forming, however, an abrupt, sloping, and rounded bevel to the abactinal area. In relation to one another the surface of the plates forms a continuous plane. On the inner-

most plates of the ray their height is fully three times the length, and diminishes gradually and slowly up to the extremity, the height being the greatest dimension throughout. The surface of the plate is covered with short, comparatively large, uniform, flat-lying, squamiform papillæ, three to four vertical series occupying the whole length of the plate. Normally the supero-marginal plates are entirely devoid of true spinelets, but six or eight on each side of a ray may bear a very small upright thornlet, little larger than the squamules, standing upright on their abactinal margin ; most of these are on successive plates, the series usually terminating about midway between the extremities.

The infero-marginal plates correspond exactly to the superior series, their length is the same, and their height is perhaps a shade greater than that of the companion plate. Their surface is covered with precisely similar squamules ; indeed, so uniform is this covering that it is very difficult to make out superficially where the junction of the superior and inferior plates exactly is. The infero-marginal plates are destitute of any true spines. The infero-marginal plates are confined entirely to the lateral wall of the ray, and do not curve upon the actinal surface.

The adambulacral plates are large and pentagonal in shape, with a prominent angular margin towards the furrow. Their armature consists of a furrow or marginal series of five short, subequal, papilliform spinelets, which stand vertically, the median one being subtriangular in section, having two sides conformable with the facets of the plate which form the angular prominence above mentioned. At each end of the series stands another spinelet, which might at first sight be ranked as belonging to the furrow series, but they stand on the actinal surface of the plate. On the actinal surface of the plate, behind the furrow series, are two or three short, flattened, and almost squamule-like spinelets, forming a somewhat irregular line with the two spinelets just mentioned ; and these are often posed in such a manner as to close against the marginal series, and may thus form perhaps an incipient pedicellarian apparatus. External to this is a more or less regular longitudinal series of three or four similar papilliform spinelets. All these spinelets are in membranous sheaths, and are very stumpy, papilliform, and often compressed.

The mouth-plates are very elongate and narrow, and the united pair extend far over the actinostome. Their armature is very simple, and consists of a marginal series of ten or eleven small, subequal, compressed, obtuse, papilliform spinelets on each plate, standing vertically ; the series extending fully two-thirds the length of the plate. The innermost spinelet in each series is more than twice the size and length of the others, and these form a prominent parallel pair at the mouth-angle, directed at a slight angle over the actinostome. On the actinal surface of each plate is a single longitudinal series of about twelve or thirteen short, robust, and rounded papillæ, which become very low and almost granular at the outer end of the plate. These two series constitute the whole armature of the plate.

The actinal intermediate plates, though occupying a very limited area in the interradial region, extend very nearly to the extremity of the ray, being, however, on the outer part

of the series mere band-like strips, and finally become gradually more or less aborted until they disappear altogether. These plates bear uniform and more or less squamule-like papillæ, invested with membranous sacs, and scarcely distinguishable from the covering of the marginal plates, with which they appear to form a continuous series, and also with the armature of the adambulacral plates.

No anal aperture is distinguishable. The central epiproctal prolongation is conical and well-defined, rising abruptly from the general paxillar area to a height of about 1·5 mm.

The madreporiform body is oval, and is situated at about its own diameter distant from the margin of the paxillar area. Its surface is traversed by very few, widely spaced furrows, convolution being chiefly limited to the two extremities of the oval, and a consequently simple appearance results.

Colour in alcohol, a bleached yellowish white.

Young Phase.—A small example from Station 46 (R = 15 mm., r = 5 mm.), which I first thought might be a distinct species, I now place provisionally as the young of *Phoxaster pumilis*. It accords in all essential points with the form above described, but in comparison presents the following differences. The tapering of the rays is more abrupt; the paxillar area is less contracted—the marginal plates being scarcely visible when viewed from above, so slight is their curvature, and the paxillæ are composed with great regularity of four truncate and compactly fitting papillæ; occasionally there are only three, but it is very rare to find cases of more than four. The armature of the adambulacral plates is rather simpler, but fully conforms to the general character and arrangement seen in the adult. The epiproctal cone is quite as large as in the much larger example, and is consequently more conspicuous. The general abactinal area is slightly inflated. The ocular or terminal plates bear three prominent spinelets, one central in the median abactinal line, the others lateral.

Colour in alcohol, a slightly bluish grey shade over the paxillar area.

Localities.—Station 44 or 45.

Station 44. Off the coast of North America, east of Maryland. May 2, 1873. Lat. 37° 25′ 0″ N., long. 71° 40′ 0″ W. Depth 1700 fathoms. Blue mud. Bottom temperature 36°·2 Fahr.; surface temperature 56°·5 Fahr.

Station 45. Off the coast of North America, east of Delaware. May 3, 1873. Lat. 38° 34′ 0″ N., long. 72° 10′ 0″ W. Depth 1240 fathoms. Blue mud. Bottom temperature 37°·2 Fahr.; surface temperature 49°·5 Fahr.

Station 46. Off the coast of North America, east of New Jersey. May 6, 1873. Lat. 40° 17′ 0″ N., long. 66° 48′ 0″ W. Depth 1350 fathoms. Blue mud. Bottom temperature 37°·2 Fahr.; surface temperature 40°·0 Fahr.

Genus *Bathybiaster*, Danielssen and Koren.

Bathybiaster, Danielssen and Koren, Nyt Mag. f. Naturvidensk., 1883, Bd. xxvii. 4. Hefte, p. 285; Den Norske Nordhavs-Expedition, 1876–78, Zoologi, xi. Asteroidea, 1884, p. 94.

This genus was established by Danielssen and Koren for a North Atlantic Asterid which had previously[1] been described by them under the name of *Astropecten pallidus*. The structure and character of the genus and species are fully discussed and admirably illustrated in their monograph of the Asteroidea collected by the Norwegian North Atlantic Expedition.

Chorology of the Genus Bathybiaster.

α. *Geographical distribution*:—

Atlantic: Two species between the parallels of 60° and 80° N.
Bathybiaster pallidus off the Norwegian coast and Spitzbergen.
Bathybiaster vexillifer in the Faeröe Channel.

Pacific: One species between the parallels of 45° and 55° S.
Bathybiaster loripes off the western coast of South America, near the entrance to the Strait of Magellan.

Southern Ocean: One species between the parallels of 45° and 55° S.
Bathybiaster loripes, var. *obesa*, off Kerguelen and Heard Island.

β. *Bathymetrical range*: 75 to 1215 fathoms.
Greatest range of one species: *Bathybiaster pallidus*, 412 to 1215 fathoms.

γ. *Nature of the Sea-bottom*: *Bathybiaster loripes* is found on Blue mud, and *Bathybiaster loripes*, var. *obesa*, on Volcanic mud. *Bathybiaster pallidus* is found on Clay, and in its greatest depths on Biloculina clay.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Bathybiaster loripes . . .	Pacific.	245	Blue mud.
Bathybiaster loripes, var. *obesa* .	Southern Ocean.	75 to 120	Volcanic mud.
Bathybiaster pallidus . .	Atlantic.	412 to 1215	Clay.
Bathybiaster vexillifer . .	Atlantic.	344	.....

[1] *Nyt Mag. f. Naturvidensk.*, 1877, Bd. xxiii. 3die Hefte, p. 62, tab. iii. figs. 1–7.

1. *Bathybiaster loripes*, n. sp. (Pl. XXXVI. figs. 1 and 2; Pl. XLII. figs. 1 and 2).

Rays five. R = 82 mm., $r = 14{\cdot}5$ mm. $R > 5{\cdot}5\ r$. Breadth of a ray near the base (between the third and fourth supero-marginal plates), 15 mm.

Rays moderately elongate, tapering continuously from the base to a finely pointed extremity. Lateral walls high and nearly vertical. Interbrachial arcs acutely rounded. Abactinal surface slightly inflated over the disk, and very slightly convex along the rays. Actinal surface of the rays convex and merging gradually into the lateral wall, which gives the rays a distinctly cylindrical appearance when viewed from below. On the other hand, when seen from above they appear more or less flat in consequence of the small degree of convexity of the abactinal area.

The abactinal surface of the disk and rays is covered with numerous rather small and closely crowded paxillæ. These are low and of uniform height throughout, and consist of seven to twelve small, very short, clavate or flaring, skin-covered, papilliform spinelets —one or two irregularly central, and the whole forming a more or less compact and flat-topped group. Often two or three thinner and more delicate spinelets may be seen on the outside of the group. The paxillæ diminish in size in the central area of the disk, and in the immediate centre become extremely small and indistinguishable as separate paxillæ; there is also a more or less strongly marked tendency to develop a conical prominence in the centre of the abactinal area. The paxillæ gradually diminish in size as they proceed along the ray, and become very small at the extremity. A more or less clearly defined arrangement in transverse lines is discernible at the sides of the paxillar area along the ray, but along the median line no order can be made out, nor are the paxillæ there distinguished by any difference in size.

The supero-marginal plates, sixty-two in number from the median interradial line to the extremity, are confined entirely to the lateral wall of the ray; they are high and short, the height being more than twice the length. On the inner part of the ray the height is even three times the length and sometimes more. The surface of the plates is covered with small, uniform, squamiform papillæ, covered with membrane, which are more or less closely appressed to the surface, their direction being upward, or towards the abactinal surface; and the squamules along the margins of the plate have a slight inclination over the suture-line, which is thus emphasised superficially. At the extreme abactinal edge of the plate is a short, conically-outlined but flat and squamule-like spinelet, very little longer than broad, which is directed perpendicularly to the plane of the abactinal surface, and to which this series of spinelets forms a well-defined boundary.

The infero-marginal plates correspond exactly to the superior series, their length is the same and their height subequal to those above described, or slightly less on the inner part of the ray. The surface of the plates is covered with squamule-like papillæ similar to those on the supero-marginal plates, and there is a similar small, short, flat, pointed and squamule-like spinelet close to the abactinal edge of the plate; the series of these forming along

the ray a longitudinal line which indicates the division of the superior and inferior series of plates. At the actinal edge of the plates is a slightly longer, though still very short, flattened and lancet-like spinelet; and the series of these is likewise continuous throughout the ray. In large examples, on the innermost ten or twelve plates, may be found a short, flattened, squamule-like spine similar to those above described, placed on the middle of the plate, both in the superior and inferior series, forming two exactly intermediate short incipient series.

The adambulacral plates are rather large and long, with a prominent angular margin towards the furrow. Their armature consists of an inner or furrow series of five remarkable spinelets enveloped in membrane. The median spinelet is the longest, and is directed over the furrow at a right angle to the direction of the ray. It is compressed laterally, more or less curved, often truncate at the extremity, and resembles a scimitar with broad and flaring blade. The spinelet on each side is usually peculiarly curved, suggesting the shape of a boomerang, and is flattened in the direction of the ray and has its convexity turned towards the median spinelet. Often these spinelets appear clavate in consequence of the fulness of the membranous sac in which they are encased. The outer spinelet on each side is rather smaller than those just described, and has with its investing membrane a distinctly papilliform character. On the actinal surface of the plate are normally three longitudinal series of flattened squamiform papillæ, covered with membranous sacs, all of uniform height, often somewhat irregular in position, and with three to six in each series, the lines being often badly defined. These papillæ are similar in character to, and indistinguishable from, those on the actinal intermediate and infero-marginal plates: indeed, when viewed superficially, it is usually impossible to say where the one series ends and the other begins.

The mouth-plates are elongate and very narrow, the united pair having a long fusiform outline. Their armature consists of a marginal series of sixteen to eighteen short, cylindrical, obtusely-rounded papillæ on each plate, increasing slightly in length as they approach the anterior end; the innermost two are larger than the rest, often more or less curved; and the innermost frequently has a boomerang form with its convexity directed towards the corresponding spinelet of the companion plate, producing a character at once conspicuous and remarkable. On the actinal surface of each plate is a single uniserial row of low, broad, round-topped, transversely compressed, and closely crowded papillæ. About sixteen or seventeen papillæ are in each series, and their breadth is nearly as great as that of the plates; the marginal series above noticed stand vertically and are appressed to the side of the superficial series. All the papillæ are invested with membrane.

The actinal interradial areas are narrow, but are occupied by numerous small imbricating intermediate plates; and these extend nearly to the extremity of the ray, in the form of elongate narrow plates intermediate between the adambulacral and infero-marginal plates. They bear skin-covered papillæ precisely similar to those on the adambulacral and infero-

marginal plates, the whole forming a uniform covering which prevents the possibility of distinguishing the individual plates on superficial examination. Some of these papillæ appear to simulate incipient pedicellariæ, but their character is not well defined.

The madreporiform body is small and oval, situated a little on the outer side of a point midway between the margin and the centre of the disk; and its surface is grooved with comparatively few, narrow, highly convoluted, and irregular striation furrows, wide apart, causing it to have a rather coarse appearance.

Colour in alcohol, a bleached yellowish grey; sometimes with traces of a dark brown or faded purple shade on parts of the paxillar area, which lead to the inference that that might probably have been the original colour.

Locality.—Station 311. Off the western coast of South America, near the entrance to the Strait of Magellan, opposite Port Churruca. January 11, 1876. Lat. 52° 45′ 30″ S., long. 73° 46′ 0″ W. Depth 245 fathoms. Blue mud. Bottom temperature 46°·0 Fahr.; surface temperature 50°·0 Fahr.

Remarks.—The peculiar skin-covered papillæ or spinelets, regarded by Danielssen and Koren[1] as sessile pedicellariæ in their admirable description of *Bathybiaster pallidus*, seldom seem in this species to appear so pedicellaria-like, or to be so highly specialised, as those described in the North-Atlantic form. I have therefore refrained from speaking of them definitely as pedicellariæ in the foregoing description. When, however, the voluminous membranous sac which invests each papilla or spinelet is folded, or injured at the extremity by slight breakage, the superficial resemblance is very striking to the structures described by the Norwegian naturalists. In some of the examples before me, the injury to the sac (in the form of a transverse slit) appears to have taken place during the life of the animal, probably by abrasion when passing over some rough surface, and the margins of the break are somewhat thickened, as if during subsequent healing.

The median spinelet in the furrow series of the adambulacral armature is not so highly specialised in the Southern as in the Northern form. It distinctly simulates, however, its character, the spinelet being covered with an extensive sac in which sometimes a supplementary calcareous lamina is present. The papulæ on the paxillar area may, under favourable circumstances, be well seen in the Southern form.

Notwithstanding these differences, after reviewing its structure as a whole, I feel little hesitation in referring the present species to Danielssen and Koren's well-defined genus *Bathybiaster*.

1*a*. *Bathybiaster loripes*, var. *obesa*, nov.

In a large series of examples from Kerguelen and Heard Island several small variations in detail may be noticed, which from their constancy appear worthy of special recognition.

[1] *Loc. cit.*, pp. 90–92.

It may be observed that the Southern-Ocean forms, when compared with those from South America, have the rays broader at the base, and though relatively shorter are rather more distinctly cylindrical, the union of the abactinal and lateral areas being less angular and less conspicuous. The abactinal area is habitually much more inflated, which gives the variety a conspicuously puffed-up appearance. The small isolated spinelets or enlarged squamules on the marginal plates are smaller and less developed; and in young examples may be absent altogether from the infero-marginal plates and represented on the summit of the supero-marginal plates by a squamule only very slightly greater than those forming the rest of the covering of the plates. The peculiar curvature of the lateral spinelets in the adambulacral armature is less pronounced and is often scarcely noticeable. These modifications, viewed in conjunction with their constancy and the wide separation of the localities, appear to me, after a careful study of a large series of examples, sufficient to warrant the recognition of the variety by name. The colour in alcohol of the variety is also different, being of a warmer shade, approaching pink or light pinkish brown.

An example from Heard Island dredged in 75 fathoms is fully twice as large as the generality of specimens belonging to this species collected during the Expedition. In the two examples from this locality the rays are not relatively so broad at the base as in the Kerguelen specimens, and are more angular at the junction of the abactinal and lateral areas: they have notwithstanding the "obese" appearance; and I have provisionally ranked them with the variety. Their colour in alcohol is somewhat darker.

Localities.—Station 149H. Off Cumberland Bay, Kerguelen Island. January 29, 1874. Depth 127 fathoms. Volcanic mud.

Station 151. Off Heard Island. February 7, 1874. Lat. 52° 59′ 30″ S., long. 73° 33′ 30″ E. Depth 75 fathoms. Volcanic mud. Surface temperature 36°·2 Fahr.

2. *Bathybiaster vexillifer*, Wyville Thomson, sp.

Archaster vexillifer, Wyville Thomson, 1873, The Depths of the Sea, p. 150, fig. 25.

Locality.—"Porcupine" Expedition:

Station 76. 1869. In the Faeröe Channel. Lat. 60° 36′ N., long. 3° 58′ W. Depth 344 fathoms. Bottom temperature – 1°·1 C.; surface temperature 10°·1 C.

Remarks.—This species is included here on the strength of the description and figure given by Sir Wyville Thomson. I have never seen the type or any other specimen from the "Porcupine" collection which can be referred to it. Danielssen and Koren[1] have already pointed out the probability that the form belongs to this genus, a view in which I entirely concur, so far as judgment can be drawn from the description and woodcut published in The Depths of the Sea. Viguier,[2] on the other hand, has expressed the opinion

[1] Den Norske Nordhavs-Expedition, 1876–78, Zoologi, xi. Asteroidea, 1884, p. 94.

[2] *Archives de Zool. expér.* 1878, t. vii. p. 240.

that the form should be referred to *Astropecten*, if the figure is correct. This view appears to me altogether untenable, unless the description is also wrong.

There are several starfishes in the Museum at Stockholm, which are referred to this species, and in my opinion correctly, so far as my knowledge, limited to the description of Thomson's type, justifies such an expression. I have not, however, examined the specimens with reference to microscopic details, and therefore confine myself to the simple statement of their existence. The examples in question, which were collected by the "Ingegerd" and "Gladan" Expedition in 1871, were dredged in Baffin's Bay, lat. 67° 26′ N., long. 58° 29′ W., at a depth of 692 fathoms, and off Omenak, on the west coast of Greenland, in 122 fathoms.

Subfamily Luidiinæ, Sladen, 1887.

Genus *Luidia*, Forbes.

Luidia, Forbes, Mem. Wern. Soc., 1839, vol. viii. p. 123.
Hemicnemis, Müller and Troschel, Monatsber. d. k. Akad. d. Wiss. Berlin, 1840 (April), p. 105.
Petalaster, Gray, Ann. and Mag. Nat. Hist., 1840 (November), vol. vi. p. 183.

This well-known and sharply defined genus constitutes a very distinct type, the characters of which are remarkably constant and subject to comparatively slight modification, as exhibited in the range of species at present known.

Two points in the morphological structure of *Luidia*, which are highly significant from a phylogenetic point of view, may here be referred to in justification of the course I have taken in placing the genus in a distinct subfamily. The first is the correspondence of the infero-marginal and adambulacral plates, and the second is the presence of a small intermediate plate between each infero-marginal and adambulacral plate. The correspondence of the infero-marginal and adambulacral plates has already been noticed by Alex. Agassiz[1] and Viguier;[2] but the intermediate plate, notwithstanding its importance from a systematic point of view, has strangely hitherto been overlooked by all observers: in fact, the assertion of its presence is in direct opposition to the statements of other writers on the group. Thus Viguier,[2] who has made a careful study of the details of the Asterid skeleton, states that in *Luidia* the marginal and adambulacral plates alone constitute the actinal skeleton of the rays, and that it is only in the interradial angles that intermediate plates—smaller and less numerous than in *Astropecten*—are intercalated between the two series. The same opinion is held by Perrier,[3] who, in his recent work on the Asteroidea of the "Blake" Expedition, regards the contiguity of the marginal and adambulacral plates as a character diagnostic of the family Astropectinidæ, the genus *Luidia* being included in this category.

In the face of these statements I should have hesitated in according a special import-

[1] North American Starfishes, *Mem. Mus. Comp. Zoöl.*, Harvard, vol. v. No. 1, 1877, p. 117.
[2] *Archives de Zool. expér.*, 1878, t. vii. p. 228.
[3] *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi. p. 266.

ance to the plate in question if my observations had been limited to a single species, but I have detected the presence of the intermediate plate in every species I have examined critically (small and more or less aborted in some cases it is true, but present in all); and I can assert its existence in all the forms included in the following synoptic table:—

Synopsis of the Species included in the Genus Luidia *herein described.*

A. Certain paxillæ bearing a large central spine on the tabulum.
  a. Rays eight to ten. Spine-bearing paxillæ separated from the marginal plates by three longitudinal series of plain paxillæ. Plain paxillæ on the median area of the ray with several papilliform granules on the tabulum, scarcely larger than the encircling series. Infero-marginal plates with five spines gradually increasing in size as they approach the margin of the ray. Often two pedicellariæ behind, and forming a serial line with, the spines composing the adambulacral armature . . . . . *aspera.*
  b. Rays five. Spine-bearing paxillæ separated from the marginal plates by two longitudinal series of plain paxillæ. Plain paxillæ on the median area of the ray with one large tubercle-like central granule. Infero-marginal plates with the lateral (and sometimes a second spine) much longer than the others. One pedicellaria behind the adambulacral armature, and often absent . . . . . *alternata.*

B. Paxillæ without a large central spinelet.
  a. Paxillæ with a quadrate tabulum.
    a. Lateral spine very short, compressed and robust. Forficiform pedicellariæ on the infero-marginal plates. Valvate pedicellariæ above the infero-marginal plates . . . . . *limbata.*
    b. Lateral spine long, delicate, tapering. No forficiform pedicellariæ on the infero-marginal plates. No valvate pedicellariæ present . . . *clathrata.*
  b. Paxillæ with a stellate crown.
    a. Adambulacral armature forming a single transverse series continuous with the spines on the infero-marginal plates.
      α. Seven rays. Pedicellariæ three-jawed.
        i. One spine on the actinal area of the adambulacral plates, long, robust, cylindrical, sometimes with a small unequal companion. Pedicellariæ very large, three-jawed, nut-shaped, very broad at the base, nearly as broad as long. Infero-marginal plates with three or four spines, the outer two or three subequal, the lateral or median one the longest . . . . . *ciliaris.*
      β. Five rays. Pedicellariæ two-jawed.
        i. One spine on the actinal area of the adambulacral plates. Pedicellariæ long and spine-like.
          1. The actinal spine of the adambulacral armature short, robust, conical. The pedicellariæ with delicate spine-like jaws. Infero-marginal plates with three spines, the lateral one long, the other two much smaller, less than the actinal spine of the adambulacral armature . . . . . *longispina.*
        ii. Two spines on the actinal area of the adambulacral plates. Pedicellariæ short and papilliform.

1. Actinal spines of the adambulacral armature very long, equal, delicate, needle-like, and slightly curved. Pedicellariæ very small, resembling clavate papillæ. Infero-marginal plates with three spines, the lateral and median one long and equal, the inner one rather shorter. Rays long and gradually tapering. Paxillæ with no robust central spinelet, but sometimes two or three of the same size as the encircling series . . . . . *africana.*

2. Actinal spines of the adambulacral armature, short, cylindrical, equal, delicate. Pedicellariæ very few, small, papilliform. Infero-marginal plates with three spines, the lateral and median one long and equal, the inner one smaller. Rays short and abruptly tapering. Paxillæ with a short robust central spinelet. . . . . *sarsii.*

b. Adambulacral armature not forming a single transverse series continuous with the spines on the infero-marginal plates.

a. Paxillæ at the sides of the rays with a slightly quadrate character. A large pedicellaria accompanies the outer spinelet on the actinal surface of the adambulacral plates; the pedicellaria and spine standing as a pair side by side behind the single median and furrow spines . . . . . *forficifer.*

Chorology of the Genus Luidia.

a. Geographical distribution:—

Atlantic: Ten species between the parallels of 65° N. and 40° S.

On the eastern side: *Luidia sarsii*, in the northern area, from the coast of Norway to the British Islands. *Luidia ciliaris*, from the Faeröe Channel in the North to the Mediterranean. **Luidia africana*, off the coast of Morocco and extending to the extreme southern point of Africa. *Luidia senegalensis*, off the west coast of Africa, and extending to the Antilles and Brazil.

On the western side: **Luidia clathrata*, extending from North Carolina, through the West Indian area, as far south as Brazil (Rio Janeiro). *Luidia elegans*, off North Carolina and in the West Indian area. *Luidia variegata*, in the Gulf of Mexico, off the mouth of the Mississippi. *Luidia convexiuscula*, *Luidia barbadensis*, and **Luidia alternata*, in the West Indian area, the last mentioned extending northward to the coast of Florida and southward to Bahia.

Indian Ocean: Three species between the parallels of 30° N. and 10° S.

Luidia savignyi, in the Red Sea and off the east coast of Africa. *Luidia maculata*, in the Indian Ocean from the coast of Africa in

the west and extending to Java in the Eastern Archipelago, and thence to the Pacific northward to Japan. *Luidia hardwickii* is reputed to be from the Indian Ocean, but the exact locality is unknown.

Eastern Archipelago: Five species between the parallels of 20° N. and 10° S.

**Luidia longispina* and **Luidia aspera*, off the Philippine Islands, the latter extending to the north of New Guinea. **Luidia forficifer*, in the Arafura Sea. *Luidia maculata*, off Java, and extending into the Indian and Pacific Oceans. *Luidia chefuensis*, off Singapore.

Pacific: Eight species between the parallels of 40° N. and 20° S.

On the western side: **Luidia limbata*, *Luidia quinaria*, and *Luidia maculata*, off the coast of Japan, the last mentioned extending into the Eastern Archipelago and Indian Ocean.

On the eastern side: *Luidia californica* and *Luidia foliata*,[1] off the coast of California. *Luidia brevispina* and *Luidia columbiæ*, off the coast of Mexico, the former extending to the Sandwich Islands and the latter to Panama. *Luidia bellonæ*, extending from Panama to Peru as far south as Callao.

The species collected by the Challenger Expedition are indicated in the above list by an asterisk.

β. *Bathymetrical range:* Shallow water to 374 fathoms.

All the species are found in the Littoral zone, and four only pass into the Continental zone, viz.: *Luidia sarsii*, *Luidia elegans*, *Luidia convexiuscula*, and *Luidia barbadensis*. None occur in the Abyssal zone.

Greatest range of one species: *Luidia sarsii*, shallow water to 374 fathoms.

γ. *Nature of the Sea-bottom:* Generally sandy, or sandy mud; but unfortunately the definite character of the bottom inhabited by *Luidia* is recorded in very few cases. Of the forms collected by the Challenger, *Luidia aspera* and *Luidia forficifer* were both found on Green mud and Coral mud; and *Luidia longispina* on mud.

Luidia elegans and *Luidia barbadensis* are recorded as frequenting calcareous pebbles, the latter being also found on fine mud. *Luidia convexiuscula* is found on Volcanic sand, madrepore sand and broken shells, as well as on a hard bottom. *Luidia sarsii* is found on sand and coarse shell-sand.

[1] I am in great doubt as to whether this form can really be distinguished from *Luidia brevispina*.

Luidia debilis of Grube has only the indefinite locality of "Africa.' The single type-specimen is so small that it might be anything, and is quite unworthy of being maintained as the type of a species. I therefore consider that the name should be discarded.

Chorological Synopsis of the Species herein described.

	Ocean.	Depth in Fathoms.	Nature of the Sea-bottom.
Luidia africana . . .	Atlantic.	Littoral to 128	.....
Luidia alternata . . .	Atlantic.	7 to 88	Volcanic sand (88 fathoms).
Luidia aspera . . .	Eastern Archipelago.	10 to 115	Green mud; Coral mud.
Luidia ciliaris . . .	Atlantic.	Littoral to 87	.....
Luidia clathrata . . .	Atlantic.	7 to 25	.....
Luidia forficifer . . .	Eastern Archipelago.	6 to 28	Coral mud; Green mud.
Luidia limbata . . .	Pacific.	5 to 25	.....
Luidia longispina . . .	Eastern Archipelago.	20	Mud.
Luidia sarsii	Atlantic.	Littoral to 374	Sand; coarse shell-sand.

1. *Luidia aspera*, n. sp. (Pl. XLIII. figs. 1 and 2; Pl. XLV. figs. 9 and 10).

Rays eight to ten. R = 170 mm.; $r = 20$ mm. (R = 168, $r = 19$). R = 8·5 r. Breadth of a ray at the widest part near the base, 16 to 17 mm.

Rays elongate in relation to the size of the disk, thick, robust, of a slightly depressed subcylindrical form, constricted for a short distance near the base, then tapering from the widest part slowly and gradually up to the pointed extremity. Abactinal surface convex, but flattened along the median radial line and upon the disk. Actinal surface rounding gradually to the margin. Lateral walls rounded.

The paxillæ of the abactinal area are large, rotund in form, but with a more or less subquadrangular facies in the regular longitudinal series, which are six in number at each side of the ray. In the comparatively narrow intermediate area along the median radial line the paxillæ are slightly smaller, distinctly rotund, crowded, and irregular in disposition. Nearly all the paxillæ of the innermost three longitudinal rows (at least on the inner half of the ray), have a robust subconical spinelet about 1·5–2 mm. in length on the centre of the tabulum. This is surrounded by about eight very small, cylindrical, obtusely-rounded, papilliform spinelets likewise placed on the tabulum, often faintly subclavate, and so short that they are little more than elongate granules. External to these and at the margin of the tabulum is a series of about two dozen similar but slightly more delicate and slightly longer spinelets. Excepting of course the central large one, the spinelets on the tabulum and the marginal series all appear of equal height when drawn together. Occasional paxillæ in the three rows mentioned are devoid of the central conical spinelet, especially on the outer part of the ray, where not more than two of the longitudinal series have echinulated paxillæ. The large paxillæ between the echinulate

ones and the margin are precisely similar to those above described, excepting that they bear no large spine, their tabulum being occupied by nine or more small, equal, papilliform spinelets, which are well-spaced and radiate slightly apart as if the surface of the tabulum were slightly convex. The paxillæ of the outermost two rows are rather smaller than those of the next two rows; and those of the outermost series which represent the aborted supero-marginal plates are the smallest. The paxillæ of the median radial area are rather smaller than those of the longitudinal series; they are rotund, bear no central spine, but have six to eight papilliform spinelets on the tabulum precisely similar to those above described.

The infero-marginal plates bear along their median line a series of four to six uniform spines, placed one behind the other: the inner two are very small and delicate, scarcely worthy of being counted with the series; but the outer four are robust, tapering, and pointed, and increase in size slightly as they approach the margin, although the marginal or lateral spine is sometimes slightly smaller than its predecessor, the longest measuring about 4 mm. in length. The distance between the second and third spine from the margin is often rather greater than that between any of the others, and the space is occupied by two or three short, delicate, hair-like spinelets; one or two are also usually present between the other large spines. The margin of the keel is fringed on each side with rather large ciliary spinelets.

The adambulacral plates are broad but very short, as seen on the actinal surface, and are united by wide ligamentous bands. Their armature, which has the appearance of being borne on a narrow keel, consists of three spines, arranged one behind the other, in transverse series in relation to the axis of the ray. The innermost or furrow spine is the shortest, compressed laterally, slightly curved, slightly tapering, but more or less obtuse at the tip. The second spine is fully two-thirds longer, more robust, only very slightly compressed, very faintly bent near the base (indeed scarcely perceptibly), tapering, and rather obtusely pointed. The third spine is similar, but straight, and is usually rather more tapering and sometimes a shade shorter and more delicate than the second spine. External to this spine and close to its base is usually a three-jawed pedicellaria, wide at the base but with delicately tapering and pointed jaws, rather more than one-third the length of the spine. One or two delicate ciliary spinelets may also be present. Occasionally a second and similar pedicellaria stands between this and the spinelets of the infero-marginal plates, which is either borne on a small intermediate plate (present between the adambulacral and infero-marginal plates) or at the innermost extremity of the infero-marginal plate; or its position may be occupied by a small group of ciliary spinelets.

The mouth-plates are elongate and narrow, with a series of large actinal or superficial spines running parallel to the margin; which are normally much larger than the marginal series, and increase in size as they approach the mouth. The spines at the innermost extremity of the plates (two or four in number) are very long, and extend nearly to the centre of the actinostome.

The actinal interradial areas, which are very small and narrow, probably do not contain more than a pair or so of small intermediate plates; and the area has the appearance of being covered with small ciliary spinelets.

The madreporiform body is hidden by paxillæ.

The ambulacral tube-feet have large rounded terminal knobs.

Colour in alcohol, a snowy white, mottled with irregular patches of intensely dark-brown almost black, but lighter in some places and approaching mouse-colour. Actinal surface and lateral spines white, also the central conical spine on the tabulum of the paxillæ, whether the paxilla itself be white or black. Ocular or terminal plate white. The mottling and the sharp contrast of the patches of colour give a remarkably handsome character to this starfish.

Individual Variation.—In a ten-rayed example the paxillæ in all the regular longitudinal series at the sides of the rays may have a central conical spinelet on the tabulum, but those in the outermost two rows are much less pronounced. The rays are slightly shorter and the disk broader: R = 166 mm., r = 22–23 mm. The colour mottling may also affect the lateral spines in places.

Young Phase.—Small immature specimens, which I refer to this species, were collected at Stations 204 and 219. Each example has ten rays, and their characters accord so closely with the foregoing description that I feel little doubt about placing them as the young of *Luidia aspera*. The largest has a radial measurement of 45 mm. As might naturally be expected at this early stage of growth, the central spinelet on the tabulum of the paxillæ near the sides of the rays is very feebly developed, and is in fact so small as to almost escape notice on superficial examination. Otherwise the characters of the adult are well displayed.

Localities.—Samboangan, Philippine group. Depth 10 fathoms.

Station 204. Off Tablas Island, Philippine group. November 2, 1874. Lat. 12° 43′ 0″ N., long. 122° 9′ 0″ E. Depth 100 to 115 fathoms. Green mud. Surface temperature 84°·0 Fahr.

Station 219. North of Admiralty Island. March 10, 1875. Lat. 1° 54′ 0″ S., long. 146° 39′ 40″ E. Depth 150 fathoms. Coral mud. Surface temperature 84°·0 Fahr.

Remarks.—This species is characterised by the form of the paxillæ and by the armature of the infero-marginal plates. The nearest ally in its own area of distribution is *Luidia maculata*, from which it may be distinguished by the particulars just mentioned.

2. *Luidia alternata* (Say), Lütken.

Asterias alternata, Say, 1825, Journ. Acad. Nat. Sci. Philadelphia, vol. v., pt. 1, p. 144.
Luidia alternata, Lütken, 1860, Videnskab. Medd. naturh. Foren. i Kjøbenhavn for 1859, p. 42.

Locality.—Challenger Expedition: Bahia. Depth 7 to 20 fathoms.

Other Localities.—Florida, Breton Island, Tortugas, St Thomas.

Remarks.—The young forms of this species appear to me to agree so closely with the brief descriptions of *Luidia elegans*, Perrier, and *Luidia variegata*, Perrier, that after a careful study of the present series of specimens, I have felt the strongest temptation to consider that the two species just named were growth-stages of *Luidia alternata*. As I have not had an opportunity of seeing the types of either *Luidia elegans* or *Luidia variegata*, I refrain from expressing a definite opinion upon the subject. *Luidia elegans* is cited by Verrill [1] as a distinct species in the results of the "Albatross" dredgings, and this circumstance would naturally lead to the inference that the forms are perhaps better distinguished than I have supposed. At any rate the figures assigned to *Luidia elegans* in that work bear no resemblance to the species I have studied. On the other hand, *Luidia variegata* has been placed as a synonym of *Luidia alternata* by Ludwig,[2] in his account of the Asteroidea collected by Professor Ed. Van Beneden on the coast of Brazil.

I can confirm Ludwig's statement that pedicellariæ are not present in the young stages of *Luidia alternata*, from specimens collected by the Challenger.

3. *Luidia limbata*, n. sp. (Pl. XLIV. figs. 3 and 4; Pl. XLV. figs. 7 and 8).

Rays five. R = 110 mm., r = 15 mm. R = 7·3 r. Breadth of a ray near the base, at the broadest part, 18 mm.

Rays moderately long, very flat, and rather broad, tapering slowly from the base to the extremity, which is not very attenuate; frequently with a slight lateral constriction at the base. Abactinal and actinal surfaces subplane, bevelled towards the margin, which is subangular, slightly rounded.

The paxillæ of the abactinal area are large, compact, closely fitting, and square, except along the median radial line and the centre of the disk. The larger paxillæ bear on the tabulum about a dozen, or even more, low, hemispherical granules, subequal, comparatively large and well-spaced, and round the margin a series of very small, short, cilia-like spinelets, about two dozen or more in number, the series often appearing to be double. There are three to four regular longitudinal series of square paxillæ at the sides of the ray. In the intermediate area along the median radial line the paxillæ are smaller, and have a tendency (more marked in some examples than others) to become rounded or irregular in form.

The paxillæ, which represent the aborted supero-marginal plates, are remarkable for bearing on their tabulum a broad, low, valvular pedicellaria resembling the form frequently found in Pentagonasteridæ. These pedicellariæ are most numerous in the neighbourhood of the interbrachial arcs, and may there extend upon the adjacent one or two series of longitudinal paxillæ. Along the ray, however, they are generally confined to the outermost or "supero-marginal" series. Sometimes on the inner part of the ray there are two pedicel-

[1] *Report of Commiss. Fish and Fisheries* for 1883, Washington, 1885, p. 543, pl. xiii. figs. 39, 39*a*.

[2] *Mém. Cour. Acad. roy. Belgique*, 1882, t. xliv. p. 9.

lariæ on one tabulum; but towards the extremity of the ray very few are present at all. Rarely a pedicellaria may be composed of three valves, as in some Pentagonasteridæ, the valvate character of the organ being still maintained. Occasionally similar pedicellariæ may be found on the other paxillæ of the abactinal surface, but their occurrence there is rare.

The infero-marginal plates bear only one lateral spine, placed at the outer end of the plate, directed outward and often more or less appressed to the margin of the ray. This spine is short, not more than 2·75 mm. in length, compressed, though rather robust, tapering, pointed, and often subfusiform in outline. On the median keel of the plate is a series of small, subequal, squamiform spinelets, rather more than one-third the length of the lateral spine, compressed, tapering, sometimes pointed, but more frequently obtuse; more or less appressed to the plate and directed at an angle outward and towards the margin, over the aboral margin of the infero-marginal plate. Additional similar spinelets may be present on the inner side of this series and with the same direction, but this part of the plate is usually occupied by very much smaller spinelets, which are also often directed over the adoral margin, *i.e.*, at an angle adorally and towards the lateral margin. Occasionally the place of one of the larger spinelets is occupied by a two-jawed forficiform pedicellaria, often near the base of the lateral spine. The margins of the ridge are fringed with numerous, delicate, equal, cilia-like spinelets; and the walls of the deep fasciolar furrow at the outer or upper part of the plates is densely covered with remarkably fine ciliary spinelets.

The armature of the adambulacral plates normally consists of three spines and one large two-jawed forficiform pedicellaria. The three spines are arranged one behind the other, *i.e.*, in transverse series in relation to the axis of the ray. The innermost or furrow spine, which is the shortest, is delicate, compressed laterally, tapering, and slightly curved; the second spine is slightly longer, more robust, subtriangular in section, with an edge towards the furrow, sometimes slightly compressed laterally, tapering, pointed, and very faintly geniculate near the base. The outermost spine is subequal in length to the last noticed, but straight, tapering, and obtusely pointed. The pedicellaria stands at the adoral side of the outer spinelet, to which it is subequal in length; it is large and expanded at the base, with a large lunule, but tapering, attenuate, and pointed at the tips of the jaws. On the outer edge of the plate are usually two or three very delicate, short, cilia-like spinelets.

The infero-marginal plate is separated from the adambulacral plate throughout the ray by a small well-defined intermediate plate. This on the inner part of the ray may bear a comparatively large two-jawed forficiform pedicellaria, similar to, but rather smaller than, that on the adambulacral plate, and two or three small cilia-like spinelets; but usually along the greater part of the ray, and always on the outer part, only a few small ciliary spinelets are present.

The mouth-plates are comparatively small. Each plate bears at its innermost point a large forficiform pedicellaria, forming a pair directed horizontally over the actinostome;

and sometimes a second pair stand immediately below these, in the place of the first actinal or superficial spines. The marginal spines and actinal spines are subequal to one another in size, and diminish as they recede from the mouth; the actinal spines forming a series parallel to the median suture of the mouth-plates.

The actinal interradial areas are very small, and do not contain more than two or four small intermediate plates, which bear either a forficiform pedicellaria or a group of small ciliary spinelets.

The madreporiform body is hidden by paxillæ.

Colour in alcohol, varying between light yellowish drab and dirty greenish grey; with a very dark broad band, almost black in some specimens, dark sage green in others, along the median radial line, extending to the centre of the disk, in some specimens fading out gradually at the sides, in others terminating more abruptly. At the extreme tip of the ray the whole area is of this dark colour, whilst the ocular or terminal plate is white, and hence very conspicuous.

Locality.—Yokohama. May 6, 1875. Depth 5 to 25 fathoms.

Remarks.—This species is perhaps most nearly related to a *Luidia* from Singapore, preserved in the University Museum at Copenhagen, which bears the manuscript name of *Luidia chefuensis*, Grube; but the two forms are distinguished by a number of well-defined characters. In *Luidia limbata* the paxillæ are larger and more definitely square, and the lateral spine is of a different shape. The armature of the adambulacral plates is different, wanting altogether the comb of four or more spinelets running parallel to the furrow, which in *Luidia chefuensis* succeeds the two single curved spinelets. In like manner there is no trace of the second comb, parallel to the furrow, of four to six ciliary spines, probably situated on the intermediate plate between the infero-marginal and adambulacral plates.

I should here state that I have not been able to find any published description of the species now mentioned under the name of *Luidia chefuensis*.

In the University collection at Breslau there is another *Luidia*, which bears the manuscript name of *Luidia singaporensis*, Grube, but which seems to me to be the same as von Martens' *Luidia maculata*, var. *quinaria*, and different from *Luidia chefuensis*.

I am inclined to think that the so-called variety *quinaria* of Dr von Martens is really a species distinct from *Luidia maculata*.

4. *Luidia clathrata* (Say), Lütken.

Asterias clathrata, Say, 1825, Journ. Acad. Nat. Sci. Philadelphia, vol. v. p. 142.
Luidia clathrata, Lütken, 1860, Videnskab. Medd. naturh. Foren. i Kjøbenhavn for 1859, p. 37.

Locality.—Challenger Expedition: Bahia. Depth 7 to 20 fathoms.

Other Localities.—North Carolina, South Carolina, Florida, Martinique, Hayti, St Thomas, Rio Janeiro.

5. *Luidia ciliaris* (Philippi), Gray.

Asterias rubens, Johnston, 1836, Loudon's Mag. Nat. Hist., vol. ix. p. 144, fig. 20 (*non* Linné).
Asterias ciliaris, Philippi, 1837, Archiv f. Naturgesch., Jahrg. iii., Bd. i. p. 193.
Luidia fragilissima (*pars*), Forbes, 1839, Mem. Wern. Soc. Edin., vol. viii. p. 123, tab. 3, fig. 8.
Asterias pectinata, Couch, 1840, Charlesworth's Mag. Nat. Hist., vol. iv. n.s. p. 34.
Luidia ciliaris, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 183.
Asterias imperati, Della Chiaje, 1841, Descr. e Not. degli anim. invert. della Sicilia citeriore, vol. iv. p. 57; vol. v. p. 123, tav. 135, figs. 1, 3, 4; tav. 171, fig. 25; tav. 172, fig. 8.
Luidia Savignyi (*pars*), Müller and Troschel, 1842, System der Asteriden, p. 77 (*non* Audouin).

Locality.—"Triton" Expedition:

Station 3. In the Faeröe Channel. August 8, 1882. Lat. 60° 39′ 30″ N., long. 9° 6′ 0″ W. Depth 87 fathoms. Bottom temperature 49°·5 Fahr.

Other Localities.—British Islands, East Atlantic as far north as the Cattegat, coast of France, Mediterranean.

6. *Luidia longispina*, n. sp. (Pl. XLIII. figs. 3 and 4; Pl. XLV. figs. 3 and 4).

Rays five. R=56 mm.; r=8 mm. R=7 r. Breadth of a ray at the third infero-marginal plate, 9 mm.

Rays elongate, depressed, slightly convex abactinally; slightly constricted at their junction with the disk, then faintly inflated, and afterwards tapering gradually up to the extremity. Lateral margin more or less angular. Actinal surface slightly convex.

The paxillæ of the abactinal area are delicate, distinct, and widely spaced; rather smaller and more crowded along the median radial line. Three or four regular longitudinal series at the sides of the ray. The larger paxillæ are composed of a marginal series of about a dozen very delicate spinelets, shorter than the diameter of the tabulum, from the edge of which they radiate horizontally; and three to five small spinelets on the centre of the tabulum, usually shorter and more robust than the marginal series. Occasional paxillæ, here and there, bear a single two-valved, fully developed pedicellaria usually placed at the margin of the tabulum. The pedicellaria is often of greater length than the spines there, and has quite a massive appearance in comparison with their delicacy.

The infero-marginal plates have a narrow and very prominent median keel, and the intervening fasciolar furrow between neighbouring keels is wide and well furnished with delicate cilia-like spinelets. On the ridge are borne three spinelets, at least on the inner half of the ray, subequally spaced, and placed one behind the other, forming a transverse lineal series in relation to the axis of the ray. The outermost spine, which stands at the margin of the ray, is long, delicate, cylindrical, tapering and sharply pointed, and with a very slight geniculation near the base. These spinelets are directed horizontally and at a slight angle outward, and form a very conspicuous fringe along the margin of the ray. The longest spines are about 5 mm., and are the ninth or tenth from the base, the spines

diminishing in length rapidly as they approach the disk and more slowly towards the extremity. The other two spines on the surface of the infero-marginal plates are small, slightly compressed, broad-based, tapering, sharply-pointed spinelets, not more than 1 to 1·5 mm. in length, simulating squamules rather than spinelets. At the inner end of the plate and upon the keel between the spinelets are a few very delicate, short, cilia-like spinelets. Not unfrequently the place of one of the compressed spinelets is occupied by a long delicate two-valved pedicellaria, quite as long as or longer than the spinelet. On the inner part of the ray this pedicellaria may often occupy the place of a third spinelet, and is often present near the base of the long lateral spine. The margins of the keel on the actinal area of the plate have a series of small papilliform or invested cilia-like spinelets.

The infero-marginal plate is separated from the adambulacral plate throughout the ray by a very small intermediate plate, and this is devoid of spinelets or pedicellariæ throughout.

The adambulacral plates are broader than long, united by a rather wide ligamentous band, and their armature consists of two spines. The inner or furrow spine is short and very delicate, subcylindrical or very faintly compressed laterally, slightly tapering but obtuse at the tip, faintly geniculate or curved, and directed over the furrow at an angle of 45° to the plane of the actinal surface. The second spine stands erect on the actinal surface of the plate, perpendicular to the actinal plane; it is rather longer than the furrow spine, measuring 1·5 to 1·75 mm. in length, very robust at the base, subconical, and tapering. On the outer side of this spine, or sometimes rather on the adoral side, is frequently a large attenuate two-valved pedicellaria, equal in length to the spine; and sometimes there are one or two more very small cilia-like spinelets behind the actinal spine.

The mouth-plates are small, very narrow, but prominent. Each plate bears at its innermost point a large two-jawed pedicellaria similar to those above described, but with coarser jaws, directed over the actinostome. On the actinal surface of the keel are three or four robust tapering spinelets, with a few small cilia-like spinelets between and at the margin.

The actinal interradial areas are very small; and they contain a pair of small intermediate plates on which are borne three or four small cilia-like spinelets.

The madreporiform body is hidden by paxillæ.

Colour in alcohol, a dirty light drab or greyish white.

Locality.—Station 203. East of Panay Island, Philippine group. October 31, 1874. Lat. 11° 6′ 0″ N., long. 123° 9′ 0″ E. Depth 20 fathoms. Mud. Surface temperature 85°·0 Fahr.

Remarks.—This species is characterised by the single, short, robust spine on the actinal surface of the adambulacral plates, by the long, delicate, spine-like, two-jawed pedicellariæ, and by the single long lateral spines.

7. *Luidia africana*, n. sp. (Pl. XLIV. figs. 1 and 2; Pl. XLV. figs. 1 and 2).

Rays five. R=155 to 160 mm.; r=18 mm. R >8·5 r. Breadth of a ray at the third infero-marginal plate, 18 mm.

Rays elongate, flat, rather broad at the base, and tapering slowly and gradually therefrom up to a pointed extremity. The abactinal area is plane; the lateral walls low, and the general form of the species very flat and depressed.

The paxillæ of the abactinal area are small, very minute, and closely crowded along the median line of the ray and the central area of the disk, increasing in size as they approach the sides of the ray, where two or three lateral series may be indistinctly made out. The representatives of the aborted supero-marginal plates are more or less distinctly spaced, and have a paxilla twice as broad as any of the others. The larger paxillæ of the general area are composed of a marginal series of about a dozen short, obtuse, papilliform spinelets which radiate outward almost horizontally; and two or three on the centre of the tabulum standing vertical, which are shorter and more robust. The small paxillæ along the median line of the ray have fewer spinelets, and only one central, which is more or less granuliform. Many of the medium-sized paxillæ have the tabulum occupied by a low massive hemispherical pedicellarian apparatus, formed by the modification of two or three papilliform granules, the two-valved form being the most numerous. In some specimens, however, there are comparatively few pedicellariæ, and in some the spinelets on the tabulum are nearly as long and delicate as the marginal series.

The infero-marginal plates have a high median spine-bearing keel, the fasciolar furrow between neighbouring keels being as wide as the breadth of the keel, with its walls densely covered with minute cilia-like spinelets. On the ridge are borne three moderately long, delicate, tapering, pointed spines, the longest 5 to 6·5 mm. long, the innermost slightly shortest; whilst a fourth, very much smaller and more delicate, stands near the inner extremity of the plate; these spines are subequally spaced, and form a transverse lineal series in relation to the direction of the ray. On the outer half of the ray there are seldom more than two of the long spines. At the inner end of the plate and between the spines are a few small delicate papilliform spinelets, often with a rather clavate appearance when seen in spirit, in consequence of their membranous investment.

The infero-marginal plate is separated from the adambulacral plate throughout the ray by a small intermediate plate. Upon this is borne a small, obtuse, two-valved pedicellaria, which at first sight might easily be mistaken for a clavate papilliform spinelet. These extend in large examples very nearly, if not quite, to the tip of the ray; sometimes they are accompanied by one or two small papilliform spinelets, and sometimes two or three of these may occupy the place of the pedicellaria.

The adambulacral plates bear three large spinelets, one behind the other, *i.e.*, forming a lineal series at right angles to the furrow. The innermost spine is the shortest, compressed laterally, curved and slightly scimitar-shaped, and though tapering a little

towards the tip, is obtuse there. This spinelet is normally directed over the furrow and separates the adjacent tube-feet. The other two spinelets are subequal, are a little longer than the furrow spinelets, measuring at the base of the ray 4 mm., and are delicate, cylindrical, and tapering, but truncate at the tip, and often with a faint tendency to flare. On the aboral side of the outermost spine is one very small, short, cilia-like spinelet.

The mouth-plates are elongate, narrow, and strongly keeled; their armature consists of a marginal series which extends the whole length of the plate, very small and papilliform along the line of union with the adambulacral plate proper, and only the inner three or four on the free part of the margin larger and spiniform; the innermost two on each plate are close together, often flattened and apposed, and form what may perhaps be looked upon as an incipient pedicellarian apparatus, which is directed horizontally over the actinostome at an angle of 45° to the median radial line. On the actinal surface of the plate is a lineal series of spinelets, robust and large along the greater part of the plate, but diminishing in size as they recede from the mouth, becoming rapidly mere small papillæ at the outer end of the plate.

In the very limited actinal interradial area there are generally two or three additional pedicellariæ exactly similar to those on the small intermediate plate which separates the infero-marginal and adambulacral plates along the ray.

The madreporiform body is situated very near the margin, and is usually hidden by paxillæ; its appearance is more or less spongiform rather than "madreporiform;" and the striations are coarse, with definite foramina distinctly visible here and there.

Colour in alcohol, a warm shade of brown over the paxillar area, becoming nearly brick red at the extremity of the ray; the terminal or ocular plate white. The centre of the disk and a narrow well-defined band traversing the median abactinal line of the ray are marked with a much darker colour, approaching dark purple, which gives a very striking appearance. Actinal surface a bleached yellowish white.

Localities.—Simon's Bay, Cape of Good Hope.

"Porcupine" Expedition:

Station 36. 1870. In the Strait of Gibraltar, off the coast of Morocco. Lat. 35° 35′ N., long. 6° 26′ W. Depth 128 fathoms. Bottom temperature 12°·9 C.; surface temperature 23°·8 C.

Remarks.—This species is nearly allied to *Luidia sarsii* of the North Atlantic, of which it is unquestionably the representative. Both are five-rayed forms, but *Luidia africana* is of much larger size, and the rays taper gradually from the base to the tip, giving them a very pointed and attenuate appearance. The paxillæ on the median portion of the rays are very much smaller than in *Luidia sarsii*, and the central granule is less prominent than in that form throughout. In *Luidia africana* the uppermost or lateral spine on the infero-marginal plates is the largest, whereas in the northern species this is generally smaller. In like manner, the outermost of the three spines on the adambulacral

plates is the longest and very large in the African species; in *Luidia sarsii*, on the other hand, the middle spine is the longest, and the size is by no means so great. The pedicellariæ on the actinal surface are low and hemispherical in *Luidia africana*, longer and pointed in *Luidia sarsii*. The colour marking—the dark thin band along the median radial line—is very characteristic of the form above described.

8. *Luidia sarsii*, Düben and Koren.

Asterias, n. sp., Sars. 1835, Beskrivelser og Iagttagelser over Dyr ved den Bergenske Kyst, p. 39.
Luidia fragilissima (*pars*), Forbes, 1841, Hist. Brit. Starf., p. 135.
Luydia Sarsii, Düben and Koren, 1844, Öfversigt K. Svensk Vet.-Akad. Förhandl., 1844, p. 113.
Luydia Savignyi (*pars*), Düben and Koren, 1846, K. Svensk. Vetensk.-Akad. Handl., År 1844, p. 254, tab. viii. figs. 23, 24 (*non* Audouin).

Localities.—"Porcupine" Expedition:

Station 46. 1869. Between Scotland and the Faeröe Islands. Lat. 59° 23′ N., long. 7° 4′ W. Depth 374 fathoms. Bottom temperature 7°·7 C.; surface temperature 12°·1 C.

Station 67. East of the Shetland Islands. Lat. 60° 32′ N., long. 0° 29′ W. Depth 64 fathoms. Bottom temperature 9°·5 C.; surface temperature 11°·0 C.

Station 68. East of the Shetland Islands. Lat. 60° 23′ N., long. 0° 33′ E. Depth 75 fathoms. Bottom temperature 6°·7 C.; surface temperature 11°·4 C.

"Knight Errant" Expedition:

Station 3. Off the Island of North Rona. August 3 and 4, 1880. Lat. 59° 12′ N., long. 5° 57′ W. Depth 53 fathoms.

Other Localities.—British Islands; South of Norway, extending as far north as Christiansund.

9. *Luidia forficifer*, n. sp. (Pl. XLIV. figs. 5 and 6; Pl. XLV. figs. 5 and 6).

Rays five. R = 40 mm.; r = 8 mm. R = 5 r. Breadth of a ray near the base, at the third or fourth infero-marginal plate, 9 mm.

Rays short for the genus, rather broad, tapering from the base to the extremity, and rather more rapidly on the outer part of the ray, convex abactinally. Lateral margin subangular. Actinal surface subplane.

The paxillæ of the abactinal area are comparatively large and distinct. There are four regular longitudinal series at the sides of the ray, in which the paxillæ are larger, and have more or less of a square appearance. In the intermediate space the paxillæ are smaller and subrotund. On the tabulum of the larger paxillæ are four to seven robust subgranuliform papillæ, with a series of twelve to sixteen, or more, very short stumpy conical spinelets round the margin, which radiate outwardly at an angle of about 45° to the plane of the tabulum, and not horizontally. In consequence of the shortness, number, and posture of the spinelets the paxillæ have somewhat of a tufted or bristling appearance.

On the outer part of the ray the spinelets on the centre of the tabulum become longer and more spiniform.

The infero-marginal plates are confined entirely to the actinal surface of the ray, and have a well-defined median keel. Each plate bears only one true spine, the lateral, placed at the outer extremity of the plate; it is short, thin, compressed and lancet-formed, the longest measuring about 1·5 mm. On the ridge are normally five equal-sized squamiform spinelets, about one-third the length of the lateral spine, compressed, tapering, sometimes pointed, but often obtusely rounded at the tip. These have the same direction in relation to the plate as the lateral spine, and consequently pass slightly over the aboral margin of the plate. A second series of smaller spinelets stands on the inner side of the series just described, and is usually directed along the median line of the plate; but this series is subject to much irregularity in the size, posture, and number of the spines, having sometimes one or more spinelets as large as the aboral series, sometimes directed towards one margin and sometimes towards the other. The margins of the keel are fringed with delicate cilia-like spinelets, those on the inner part of the plate having a thick and saccular investment, which gives them a robust papilliform appearance in comparison to the others.

The adambulacral plates carry an armature arranged in the following manner:—(1.) A single furrow spine, curved scimitar-like, delicate, compressed, obtuse at the tip. (2.) Immediately behind the furrow spine, a single spine slightly longer, more robust, slightly compressed or triangular, tapering, pointed, and slightly geniculate, the curvature being much less than that of the inner spine. (3.) Behind the foregoing stand either two straight spines side by side, or a spine and a pedicellaria of equal length and in the same relative positions. These are rather shorter than the second single spine above noticed; the spine is moderately robust, tapering, and pointed; and the pedicellaria has long delicate jaws, equal in length to the accompanying spinelet. The pedicellaria is usually on the adoral side, but not invariably. On a few of the plates on the inner part of the ray a second pair of spines may be present, but usually the outer part of the plate bears only two or three ciliary spinelets rather thickly invested.

The mouth-plates are prominent and extend far upward into the actinostome; each plate usually (in one example always) bears a single very large pedicellaria at its innermost point. The marginal and actinal or superficial spines are subequal in size; the former somewhat irregular in position, the latter in a series parallel to the median suture. The mouth-armature is difficult to formulate in the type specimen without preparation.

The actinal interradial areas are very small, and include only a pair of small intermediate plates, each of which bears one large pedicellaria, but shorter than those on the adambulacral plates and with more obtuse jaws. At the base of the pedicellaria are a few minute cilia-like spinelets. A small intermediate plate separates the infero-marginal plate from the adambulacral plate throughout the ray. A few of these plates on the inner-

most part of the ray may bear a single pedicellaria, but along the ray they are either naked or bear only small cilia-like, but invested, spinelets.

The madreporiform body is hidden by paxillæ.

Colour in alcohol, a bleached ashy or yellowish white.

Young Phase.—A small example was obtained at Station 188 in company with a larger specimen, which seems to me in every way identical with the type form. About the small example, however, which has a radial measurement of 18 mm., I feel much doubt as to whether it belongs to this species or to a new one. The actinal characters conform closely enough with those of *Luidia forficifer*, but on the abactinal surface the paxillæ are furnished with a robust central papilliform granule or incipient spinelet, of which no trace is found in the adult forms above described. Without more material to furnish a clue as to the intermediate stages (if such really exist), I am unable to express a definite opinion on the young example under notice.

Localities.—Station 187. Booby Island, Torres Strait. September 9, 1874. Lat. 10° 36′ 0″ S., long. 141° 55′ 0″ E. Depth 6 fathoms. Coral mud. Surface temperature 77°·7 Fahr.

Station 188. In the Arafura Sea, near the entrance to Torres Strait. September 10, 1874. Lat. 9° 59′ 0″ S., long. 139° 42′ 0″ E. Depth 28 fathoms. Green mud. Surface temperature 78°·5 Fahr.

Remarks.—This species may be distinguished by the form of the rays, by the character of the paxillæ, and by the armature of the adambulacral and infero-marginal plates.

Family Pentagonasteridæ, Perrier, 1884.

The family Goniasteridæ, as defined by M. Perrier[1] in 1875, has been recently divided by him[2] into four families, the Pentagonasteridæ, Pentacerotidæ, Antheneidæ, and Gymnasteriidæ. With this step I entirely concur, reserving only some doubt about the validity of the Antheneidæ as a group worthy of family rank, its credentials appearing to me to be more or less artificial.

The limits of the genera included in the Pentagonasteridæ have been critically and justly discussed by Perrier.[3] I have, however, ventured to differ from him in that I have limited the term *Astrogonium* to those species for which he has proposed to restore the generic name of *Stephanaster*.[4] The reasons for this step, which seems to me unavoidable, are discussed on p. 285. I have furthermore felt obliged to separate a small group of species distinguished by definite structural characters from the other Pentagonasteridæ, for

[1] Révis. Stell. Mus., p. 25 (*Archives de Zool. expér.*, 1875, t. iv. p. 289).

[2] *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi. p. 165.

[3] Révis. Stell. Mus., p. 100, *et seq.* (*Archives de Zool. expér.*, 1876, t. v., p. 6, *et seq.*)

[4] *Comptes rendus*, 1885, t. ci. p. 885; *Ann. Sci. Nat.* (Zool.), 1885, t. xix., Art. No. 8, p. 30.

which I propose the generic name of *Gnathaster*. I have also retained as genera several of the sections relegated by Perrier to subgeneric rank under *Pentagonaster*, viz., *Calliaster*, *Calliderma*, *Astrogonium*, *Stellaster*, and *Ogmaster* (= *Dorigona*). Though the characters upon which these genera are based exhibit many transitional stages, it appears to me too sweeping a measure to merge them in one generic term. That the differences should be slight and the cases of transition frequent in a large and widely distributed family such as the Pentagonasteridæ is not surprising. As, however, the morphological characters of the forms in question are in my opinion sufficient to warrant recognition, it seems to me that to lose the record of their significance by an unnecessary exercise of comprehensiveness would be a mistake.

Astrogonium and *Dorigona*, it should be mentioned, have recently been restored by Perrier[1] himself as generic names, but the sense in which they have been applied appears to me to be inadmissible, for reasons which I shall give in detail.

I have substituted the generic name *Ogmaster* for that of *Dorigona*. The starfish described by Gray[2] in 1866 under the name of *Dorigona reevesii* is the same species as that previously described by Müller and Troschel[3] in 1842 under the name of *Goniodiscus capella*. In 1865 von Martens[4] placed this form in a subgenus to which he gave the name *Ogmaster*, ranking it under *Goniaster*. The claim of this form to generic recognition has since been admitted, and it follows in my opinion that the name of the starfish in question should therefore be *Ogmaster capella* (M. & T.), von Martens. (Its synonyma are *Dorigona reevesii*, Gray, and *Goniaster mülleri*, Lütken; but not *Goniaster* (*Stellaster*) *mülleri* of von Martens.) The *Goniaster* (*Stellaster*) *mülleri* of von Martens is a true *Stellaster*, which is so nearly allied to *Stellaster childreni* that I am unable to distinguish it, and I am therefore constrained to consider *Goniaster mülleri* as a synonym of that species. Both Lütken and Perrier have been in error in regarding von Martens' form as identical with the species described by Gray as *Dorigona reevesii*.

A second form which has been referred to the genus *Dorigona* is the starfish described by Möbius[5] under the name of *Astrogonium longimanum*. This form is totally distinct from Gray's form, and merits, in my opinion, an independent generic recognition. I therefore propose for it the name of *Iconaster*. It is characterised by the naked abactinal plates margined by very remarkable valve-like plates, by the character of the adambulacral

[1] *Ann. Sci. Nat.* (Zool.), 1885, t. xix., Art. No. 8, p. 30. I would here take the opportunity of mentioning that the sheets of this Report which treat of the Porcellanasteridæ and Archasteridæ were printed off before I had seen this last mentioned important memoir by Prof. Perrier, and I was consequently unable to refer to the species described therein, as I otherwise should have done.

[2] Synop. Spec. Starfish Brit. Mus., London, 1866, p. 7, pl. 7, figs 3, 3*a*.

[3] System der Asteriden, 1842, p. 61.

[4] Ueb. Ostasiat. Echin., *Archiv f. Naturg.*, Jahrg. xxxi., Bd. i. p. 359.

[5] Neue Seesterne des Hamburger und Kieler Museums, 1859, p. 7, taf. i., figs. 5, 6. (*Abhandl. a. d. Gebiete Naturw. hrsg. v. d. naturwiss. Verein*, Hamburg, Bd. iv. Abth. 2, 1860.)

armature, and by the union of the supero-marginal plates throughout the ray. The synonyms of *Iconaster longimanus*, Möbius, sp., are *Astrogonium longimanum*, Möbius, *Astrogonium souleyeti*, Dujardin and Hupé, *Goniaster longimanus*, Lütken, *Pentagonaster longimanus*, Perrier, and *Archaster lucifer*,[1] Valenciennes.

On the grounds above detailed I consider that the name *Dorigona* should be ranked as obsolete. I am unable to express a definite opinion as to the position of several forms recently referred to *Dorigona*, but I am inclined to think that some of them will perhaps fall within the scope of the genus *Nymphaster* described on a succeeding page.

I have added to this family four new genera discovered by the Challenger, and I have also included the genus *Nectria*, which has latterly been relegated by Perrier[2] to the Linckiidæ.

The interesting genus *Anthenoïdes* described by Perrier[3] is referred by him to this family.

In concluding these notes I would remark that Perrier[4] in his latest work has again reverted to the family name of Goniasteridæ. I think this unfortunate, and in fact inadmissible, unless M. Perrier has relinquished the amended classification of the genera included in that group, proposed by him in 1884, and noticed above. The scope and significance of the family Goniasteridæ (Verrill), Perrier, 1875, is quite different from that of the family Pentagonasteridæ, Perrier, 1884. The latter I have adopted in the present work, and consider that it ought to be maintained.

Synopsis of the Genera included in the Family PENTAGONASTERIDÆ.

A. Abactinal area with rounded, polygonal, or paxilliform plates. Granules or spinelets when present co-ordinated . . . . . PENTAGONASTERINÆ.

a. Abactinal area covered with rounded or polygonal plates; sometimes subtabulate, and either smooth or bearing granules, but not forming true paxillæ.

a. Supero-marginal plates separated throughout the length of the ray by abactinal plates. Abactinal plates not margined by elongate valvular plates.

α. Actinal intermediate plates and infero-marginal plates smooth or granulose; devoid of prominent spinelets.

i. Marginal plates smooth or granulose.

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[1] In citing this erroneous reference to *Archaster* in the list of species given on p. 122 *supra* (line 21), I have inadvertently written *Dorigona longimana*, Möbius, sp., instead of *Iconaster longimanus*, Möbius, sp. The reader will please make the necessary correction. The sheet was unfortunately printed off before the error was noticed.

[2] *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1878, t. i. p. 79. (On p. 19 of the same work *Nectria* is ranked in the Goniasteridæ.)

[3] *Bull. Mus. Comp. Zoöl.*, Harvard, 1881, vol. ix., No. 1, p. 23; *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi. p. 246.

[4] *Ann. Sci. Nat.* (Zool.), 1885, t. xix., Art. No. 8, p. 30.

1. Form pentagonal, sides distinctly rectilineal. Marginal plates ordinarily few in number . . . . . *Pentagonaster.*
2. Form more or less pentagonal. Extremities of the rays dilated or rounded. Marginal plates few in number . . . . . *Astrogonium.*

ii. Marginal plates with tubercles . . . . . *Calliaster.*

β. All plates covered with membrane, and bearing only single, isolated, prominent, obtuse spinelets or elongate tubercles. No papulæ (?). No pedicellariæ . . *Chitonaster.*

γ. Actinal intermediate and infero-marginal plates spinulate, and with small prominent spinelets interspersed. Abactinal plates granulose . . . . *Calliderma.*

b. Supero-marginal plates united throughout the length of the ray. Abactinal plates confined entirely to the disk. Abactinal plates margined by peculiar valve-like plates. Abactinal plates naked . . . . . *Iconaster.*

b. **Abactinal area with paxilliform plates.**

a. Paxillæ usually stellate and spinose. Mouth-plates with a prominent keel, developed aborally into a hyaline spiniform prolongation. Tegumentary covering of the whole test more or less spiniform or papilliform. With odd interradial marginal plates . . . . . *Gnathaster.*

b. Paxillæ tabulate, bearing granules or papillæ usually prismatic in form. Mouth-plates not keeled or prominent. No odd interradial marginal plates.

α. Paxillæ confined to the disk-area. Rays long. Supero-marginal plates uniting in the median radial line, or separated only by a single series of quadrate plates.

i. Adambulacral armature arranged in longitudinal series. Infero-marginal plates devoid of prominent tegumentary spinelets. With entrenched pedicellariæ . . . . . *Nymphaster.*

ii. Adambulacral armature palmo-radiate and transverse. Infero-marginal plates spiniferous and with small prominent spinelets. No pedicellariæ . . . . . *Paragonaster.*

β. Paxillæ extending along the ray. Supero-marginal plates separated by several series of paxillæ. Small valvate pedicellariæ only, and very few in number.

i. Marginal plates large and conspicuous. Abactinal plates small and not developed into large cylindrical tabula. Pedicellariæ present . . . . . *Mediaster.*

ii. Marginal plates comparatively small. Abactinal plates very large, with enormous cylindrical tabula, bearing co-ordinated granules. No pedicellariæ . . . . . *Nectria.*

B. Abactinal area with flat stellate plates. Covered with a uniform granulose membrane . . . . . GONIODISCINÆ.
a. Abactinal area with polygonal or substellate plates, overlaid with a granulose membrane which invests the whole test.
a. Actinal area naked. Margin of test thick.
α. Infero-marginal plates with one or more lateral spines . . *Stellaster.*
β. Infero-marginal plates devoid of lateral spines . . . . *Ogmaster.*
b. Actinal area covered with a membranous skin. Margin angulated, and with a marginal fringe of small conical thornlets . . . *Leptogonaster.*
b. Abactinal area with stellate plates, leaving wide interspaces for the passage of papulæ . . . . . *Goniodiscus.*
C. Abactinal area with small stellate plates bearing true paxillæ. Actinal intermediate areas with imbricating plates in transverse series, bearing paxilliform groups of spines. . . . . MIMASTERINÆ.
a. A single genus . . . . . *Mimaster.*

Subfamily PENTAGONASTERINÆ, Sladen, 1888 (*non sensu* Viguier, 1878).

Genus *Pentagonaster*, Linck.

Pentagonaster, Linck, De Stellis marinis, 1733, p. 20.
Goniaster (*pars*), L. Agassiz, Prod. Mon. Radiaires, Mém. Soc. Sci. Nat. Neuchatel, 1835, t. i. p. 191.
Astrogonium (*pars*), Müller and Troschel, System der Asteriden, 1842, p. 52.
Goniodiscus (*pars*), Müller and Troschel, System der Asteriden, 1842, p. 57.
Hosia (*pars*), Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 279.
Tosia, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 281.

Two species only were referred by Linck to his genus *Pentagonaster*. One of them, *Pentagonaster regularis*, has not since been recognised, and, as the type is lost and its identification now could be nothing more than a guess, the name should be discarded altogether. The second form, *Pentagonaster semilunatus*, is a perfectly well recognised species, about which there is no doubt, and in my opinion it should certainly be held as the type of Linck's genus *Pentagonaster*. On these grounds I cannot agree with Perrier[1] in removing *Pentagonaster semilunatus* to the genus *Astrogonium*, as defined by him, for so long as the genus *Pentagonaster* is preserved I consider that *Pentagonaster semilunatus* must unquestionably be referred to it. The term *Astrogonium*, as used by me, is restricted to limits different from those recently assigned to it by Perrier,[2] when restoring it to generic rank.

Chorology of the Genus Pentagonaster.

a. Geographical distribution:—

ATLANTIC: Twenty species between the parallels of 75° N. and 55° S.

In the northern area, **Pentagonaster granularis*, occurs both on the eastern and the western sides, being found off the coasts of

[1] *Ann. Sci. Nat.* (Zool.), 1885, t. xix. p. 37. [2] *Loc. cit.*, p. 30.

Scandinavia, Britain, and the United States. *Pentagonaster placenta*, in the Mediterranean and Adriatic. *Pentagonaster mirabilis*, in the Gulf of Smyrna (I am in great doubt as to the distinctness of this form from *Pentagonaster placenta*). **Pentagonaster semilunatus*, off the coast of Senegal and off the Cape Verde Islands, passing thence to Brazil, and extending northward to South Carolina. It is also recorded from Zanzibar, Celebes, and China. *Pentagonaster crassus*, *Pentagonaster deplasi*, *Pentagonaster gosselini*, and *Pentagonaster perrieri* (= *Pentagonaster grandis*, Perrier),[1] off the coast of Morocco. *Pentagonaster gosselini* is also found off the Canaries and off the Azores, and *Pentagonaster perrieri* off the Azores. **Pentagonaster lepidus*, *Pentagonaster fallax*, and *Pentagonaster* (?) *elongatus*, off the Azores, *Pentagonaster vincenti*, off the Canaries, and *Pentagonaster hæsitans*, off Cape Ghir. The following series of species are all from the West Indian area and Gulf of Mexico: *Pentagonaster parvus*, *Pentagonaster grenadensis*, *Pentagonaster dentatus*, *Pentagonaster affinis*, *Pentagonaster* (?) *alexandri*, and *Pentagonaster intermedius*. (I am doubtful as to the accuracy of referring Perrier's three species, *Pentagonaster alexandri*, *Pentagonaster elongatus*, and *Pentagonaster intermedius* to *Pentagonaster* as now defined. It seems to me not improbable that the first will prove to belong to the genus *Nymphaster*, and the second perhaps to *Paragonaster*.) **Pentagonaster patagonicus*, off the eastern coast of South America, near the Atlantic entrance to the Strait of Magellan; and it is also found on the Pacific side of the Strait near the entrance to Smyth Channel.

PACIFIC: Nine species between the parallels of 40° N. and 55° S.

Pentagonaster semilunatus, off the coast of China, being also found in the Atlantic off the coasts of Brazil, South Carolina, and Senegal. **Pentagonaster japonicus* and **Pentagonaster arcuatus*, off the coast of Japan. *Pentagonaster* (?) *fonki*, off the coast of Chili. *Pentagonaster* (?) *belli* and **Pentagonaster patagonicus*, in the Strait of

[1] Professor Perrier has described (*Ann. Sci. Nat.* (Zool.), 1885, t. xix., Art. No. 8, p. 35), under the name of *Pentagonaster grandis*, a new species represented by a large series of specimens dredged during the "Talisman" Expedition off the coasts of Morocco, the Sahara, and the Azores. Unfortunately the name "*grandis*" is already appropriated to another species of *Pentagonaster*, from Western Australia, described by Gray in 1847, under the name of *Tosia grandis* (*Proc. Zool. Soc. Lond.*, 1847, p. 80; Synop. Spec. Starf. Brit. Mus. 1866, p. 11, pl. 3, fig. 1). The type of Gray's species is in the British Museum. As Perrier's form appears from the short description given to be clearly distinct, and as the locality and conditions of existence would lead to the same inference, it seems to me necessary that the name should be changed to avoid confusion. I have therefore substituted that of *Pentagonaster perrieri* for the West African species, under the conviction that the form can bear no more appropriate name than that of its able describer.

Magellan, the latter extending to the Atlantic side. **Pentagonaster astrologorum*, *Pentagonaster auratus*, and *Pentagonaster magnificus*, off the coast of Australia.

Eastern Archipelago: Two species between the parallels of 10° N. and 10° S. *Pentagonaster inæqualis* is supposed to be from New Guinea or Amboina. *Pentagonaster semilunatus* is stated to have been found at Celebes; it extends into the Pacific, Indian, and Atlantic Oceans.

Indian and Southern Oceans: Seven species between the parallels of 0° and 45° S.

The following five species are recorded to be from Australia, viz., *Pentagonaster grandis*, Gray (non *Pentagonaster grandis*, Perrier), *Pentagonaster nobilis*, *Pentagonaster ruber*, *Pentagonaster tuberculatus*, and *Pentagonaster australis* (= *Pentagonaster procyon*, Val.). *Pentagonaster semilunatus*, from Zanzibar, and extending to the Atlantic and Pacific. *Pentagonaster tuberculatus*, from Port Natal.

The species obtained during the Challenger Expedition are marked in the foregoing list with an asterisk.

The locality of the following eight species is unknown, and their names have consequently not been included in the foregoing lists:—

Pentagonaster gibbosus, Perrier.	*Pentagonaster minimus*, Perrier.
Pentagonaster lamarcki, Müller and Troschel.	*Pentagonaster ornatus*, Müller and Troschel.
Pentagonaster luzonicus, Gray.	*Pentagonaster punctatus*, Lamarck.
Pentagonaster mammillatus, Müller and Troschel.	*Pentagonaster regularis*, Linck.

The types of the three following species are not to be found, and the names should therefore be discarded in future:—

Pentagonaster luzonicus, Gray.	*Pentagonaster regularis*, Linck.
Pentagonaster punctatus, Lamarck.	

Several of the species-names of Gray and of Müller and Troschel will probably have to be discarded ultimately on account of being either duplicate names or synonyms; but as most of these doubtful forms are represented only by single examples, and are not concerned with the present report, I do not consider it desirable to interfere with them at present.

β. *Bathymetrical range:* 20 fathoms to 1500 or 1930 fathoms.

The depth of a large number of the species is not recorded, but the majority of the older ones are probably from the Littoral zone. Of the forms whose depth is known, *Pentagonaster placenta* and *Pentagonaster parvus* are confined to the Littoral zone; *Pentagonaster grenadensis*, *Pentagonaster arcuatus*, and *Pentagonaster japonicus* to the Continental zone.

Pentagonaster patagonicus is found in the Littoral zone, and passes into the Continental zone. *Pentagonaster granularis*, *Pentagonaster alexandri*, and *Pentagonaster dentatus* are found in the Littoral zone, pass into the Continental, and extend into the Abyssal zone. *Pentagonaster perrieri* (= *Pentagonaster grandis*, Perrier) is found in the Continental zone and passes into the Abyssal zone. *Pentagonaster crassus*, *Pentagonaster deplasi*, *Pentagonaster vincenti*, *Pentagonaster gosselini*, *Pentagonaster hæsitans*, *Pentagonaster lepidus*, *Pentagonaster elongatus*, *Pentagonaster fallax*, *Pentagonaster affinis*, and *Pentagonaster intermedius* have hitherto been found only in the Abyssal zone, the last named at a depth of 1930 fathoms.

Greatest range of one species: *Pentagonaster alexandri*, from 84 to 1930 fathoms. As there is some doubt about the reference of the specimen from 1930 fathoms to this species, and as I am uncertain about the species really belonging to the genus *Pentagonaster*, the following may also be cited: *Pentagonaster dentatus*, from 41 to 1500 fathoms.

γ. *Nature of the Sea-bottom:* The nature of the ground inhabited by *Pentagonaster* is recorded in the case of very few species. *Pentagonaster granularis* is found on sand, shells, and clay; *Pentagonaster parvus* on broken shells and corals, and on a hard bottom; *Pentagonaster affinis* on mud; *Pentagonaster dentatus* on Globigerina mud; *Pentagonaster japonicus* and *Pentagonaster arcuatus* on Green mud; *Pentagonaster patagonicus* on sand in 55 fathoms (Atlantic), and on Blue mud in 245 fathoms (Pacific); *Pentagonaster lepidus* on Volcanic mud in 1000 fathoms.

Chorological Synopsis of the Species herein mentioned.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Pentagonaster arcuatus	Pacific.	345	Green mud.
Pentagonaster astrologorum	Pacific.	...	... ...
Pentagonaster granularis	Atlantic.	20 to 640	Sand, shells, clay, gravel, stones.
Pentagonaster lepidus	Atlantic.	1000	Volcanic mud.
Pentagonaster semilunatus	Atlantic, Indian Pacific.	...	... ...
Pentagonaster japonicus	Pacific.	345	Green mud.
Pentagonaster patagonicus	Pacific and Atlantic, (Magellan's Strait).	55 to 245	Sand (55 fathoms, Atlantic). Blue mud (245 fathoms, Pacific).

1. *Pentagonaster semilunatus*, Linck.

Pentagonaster semilunatus, Linck, 1733, De Stellis marinis, p. 21, tab. xxiv., No. 39; tab. xxvii., No. 45; tab. xxiii., No. 37.

Asterias granularis (*pars*), Gmelin, 1789, Linn. Syst. Nat., Ed. xiii., p. 3164.

Asterias tessellata (*pars*), Lamarck, 1816, Hist. nat. anim. s. vert., t. ii. p. 552.
Goniaster cuspidatus, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 280.
Astrogonium cuspidatum, Müller and Troschel, 1842, System der Asteriden, p. 56.
Goniaster semilunatus, von Martens, 1866, Archiv f. Naturg., Jahrg. xxxii., Bd. i. p. 86.
Astrogonium dubium, Perrier, 1869, Ann. Sci. Nat. (Zool.), 5e Série, t. xii. p. 277.
Goniaster americanus, Verrill, 1871, Amer. Journ. Sci. and Arts, vol. ii. p. 130.
Goniaster africanus, Verrill, 1871, Amer. Journ. Sci. and Arts, vol. ii. p. 131.
Astrogonium semilunatum, Perrier, 1885, Ann. Sci. Nat. (Zool.), vol. xix. No. 8, p. 37.

Locality.—St Vincent, Cape Verde Islands.

Remarks.—A single small example was obtained during the Challenger Expedition, in which the rays are comparatively longer than in larger-sized specimens, but this circumstance is probably consequent on its immaturity.

This species is very widely distributed, being found on each side of the Atlantic, occurring off the west coast of Africa (off Senegal, Goree, Cape Verde Islands, and Bissagos Islands), and, on the American side, off the coasts of Brazil and South Carolina. It has also been collected off the coast of China and off Zanzibar.

In the Berlin Museum there is a specimen bearing the locality record "Ostindien," from Schönlien's collection, which is probably the example described by Müller and Troschel. The species is also stated by von Martens[1] to have been obtained at Celebes by Schönlein.

A remarkably fine series of examples from nearly all the above mentioned widely separated localities has been studied carefully by Prof. Perrier, who states that he is unable to point out any character by which these forms may be distinguished specifically.

2. *Pentagonaster granularis*, Retzius, sp.

Asterias granularis, Retzius, 1783, K. Vet. Acad. Nya Handlingar, Stockholm, t. iv. p. 238.
Asterias granularis, Abildgaard, 1789, O. F. Müller, Zool. Dan., vol. iii. p. 19, tab. xcii., figs. 1–4.
Asterias tessellata (*pars*), Lamarck, 1816, Hist. nat. anim. s. vert., t. ii. p. 552.
Astrogonium granulare, Müller and Troschel, 1842, System der Asteriden, p. 57.
Astrogonium boreale, Barrett, 1857, Ann. and Mag. Nat. Hist., 2nd ser., vol. xx. p. 47, pl. iv., figs. 5 *a*, 6.
Goniaster granularis, Lütken, 1865, Videnskab. Medd. naturh. Foren. i Kjøbenhavn for 1864, p. 146.
Pentagonaster (*Astrogonium*) *granularis*, Perrier, 1876, Révis. Stell. Mus., p. 224 (Archives de Zool. expér., t. v. p. 40).

Localities.—Challenger Expedition:

Station 49. Off the coast of the United States, south of Halifax, Nova Scotia. May 20, 1873. Lat. 43° 3′ 0″ N., long. 63° 39′ 0″ W. Depth 85 fathoms. Gravel, stones. Bottom temperature 35°·0 Fahr.; surface temperature 40°·5 Fahr.

"Porcupine" Expedition:

Station 51 (1869). In the Faeröe Channel. Lat. 60° 6′ N., long. 8° 14′ W. Depth 440 fathoms. Bottom temperature 5°·5 C.; surface temperature 10°·9 C.

Remarks.—This species is found on both sides of the northern area of the Atlantic.

[1] *Archiv f. Naturg.*, 1866, Jahrg. xxxii., Bd. i., p. 86.

Its range of depth varies from 20 fathoms to 640 fathoms; the latter depth being off the North American coast (Verrill).

3. *Pentagonaster astrologorum* (Müller and Troschel), Perrier.

Astrogonium astrologorum, Müller and Troschel, 1842, System der Asteriden, p. 54.
Pentagonaster (?) astrologorum, Gray, 1866, Synop. Spec. Starf. Brit. Mus., p. 11.
Pentagonaster astrologorum, Perrier, 1876, Révis. Stell. Mus., p. 196 (Archives de Zool. expér., t. v. p. 12).

Locality.—Sydney Harbour.

4. *Pentagonaster patagonicus*, n. sp. (Pl. XLVI. figs. 3 and 4; Pl. XLIX. figs. 3 and 4).

Rays five. R = 68 mm.; r = 43 mm. R = 1·58 r. The minor radius is thus in the proportion of about 63 per cent.

Body of large size. General form depressed and flat. Abactinal area slightly inflated in the central region and flexible. Marginal contour pentagonal with a slight stellate tendency, the extremities of the rays being pointed and slightly produced. Interbrachial arcs forming a distinct curve sweeping from tip to tip. Margin thick and more or less vertical, the rounding more bevelled on the abactinal surface than on the actinal.

The whole abactinal paxillar area is covered with small, regular, polygonal tabula or paxillæ, those in the radial areas regularly hexagonal and larger than those in the intermediate regions, which are rhomboid, and all diminish in size as they approach the margin. The larger paxillæ in the radial regions do not actually touch one another but are slightly spaced apart. These paxillæ consist of a hexagonal tabulum on a low broad base, and the tabulum is covered with low truncate granules, the marginal series of which are slightly larger than the rest and sub-prismatic or polygonal; all the granules are uniformly truncate so as to form a smooth upper surface to the tabulum, which is also slightly convex; and the edges of the paxillæ are sharply cut as if "dressed" with a knife. Occasional paxillæ at wide intervals apart bear a single small excavate pedicellaria, having two chisel-shaped or spatulate jaws, which can be drawn down more or less into the pit or cavity; the form of the jaws varies considerably, sometimes being narrow and elongate, sometimes much broader and more lamelliform; occasionally three jaws may be present. The small rhomboid tabula in the interradial regions, which are crowded and fit close to one another, have a much lower base; indeed the base appears to gradually diminish and the paxillar character to disappear as the tabula approach the margin. In the marginal region, where the tabula are smaller, faintly indicated lines may be seen to proceed inwards from the sutures of the supero-marginal plates, which have the appearance of dividing up this marginal series of small tabula into band-like series corresponding in breadth to the length of the marginal plates, four or five rows of tabula being in each band; this character is lost, however, as soon as the large hexagonal and separated paxillæ are reached. There

are six papulæ round each tabulum, corresponding in position to the angles of the hexagon, and they are separated from one another by the stellate prolongations between the plates. The five primary interradial plates (basals) are clearly discernible and are distinctly larger than any of the other tabula. They are all equidistant from the centre, being from four to five times their own diameter distant. One bounds the adcentral side of the madreporiform body and is larger than the others. The dorso-central plate may also be distinguished.

The supero-marginal plates are fifteen in number, counting from the median interradial line to the extremity. They form a conspicuous border to the abactinal area and their breadth and length are subequal, except at the extremity, where they gradually diminish in size, and the breadth is in excess of the length; the plates are slightly convex and form a bevelled edge to the paxillar area. Their surface is covered with small, low, truncate, crowded granules, excepting a small irregular oval naked space on the abactinal surface. A number of the plates bear one of the small excavate pedicellariæ, similar to those already described above, and these are frequently situated in the naked oval space.

The infero-marginal plates correspond to the superior series, and are similarly covered with small, low, crowded granules. Only five or six plates on each side of the median interradial line have small naked areas on the actinal side, which are very much less than those on the superior series and gradually diminish as they proceed along the ray. It would appear that pedicellariæ are normally not present on the infero-marginal plates. In the example under notice I have only found one plate thus furnished.

The adambulacral plates are a little broader than long, and their armature consists of a marginal series of four or sometimes five short equal spinelets, irregularly cylindrical or often more or less subprismatic, with roundly truncate tips, frequently subclavate, and on the outer half of the ray more or less compressed in the direction of the axis of the ray. At a short distance behind these are normally three low, thick, dumpy, subclavate, papilliform spinelets forming a slightly arched line traversing the plate diagonally, the aboral end of the series being nearest the marginal or furrow spinelets. External to these are a few (about five to seven) low, truncate, prismatic granules, which may either form two subregular parallel lines, or a diagonal line subparallel with the second series of dumpy papillæ, with one or more granules filling in the vacant spaces at the corners left by the obliquity of the line. These outer granules are scarcely distinguishable from those on the adjacent actinal intermediate (ventral) plates to be described below. In two or three rare instances an incipient pedicellaria is present on the adambulacral plates, but not more than that number occur in the whole of the adambulacral plates of the example under description. Pedicellariæ may therefore be said to be not present normally. Near the extremity of the ray there are not more than three furrow spinelets on each plate, and finally only two. And the second row of dumpy papilliform spinelets is at the same time represented by only two, one of which is much larger than the other, and on the terminal seventeen or eighteen

plates the larger one only is present, and is relatively increased in size and prominence in proportion to the size of the plate and the accompanying spinelets.

The mouth-plates are elongate and triangular, slightly truncate posteriorly; and the free margin of each plate forms a straight line in continuation of the series of adambulacral plates which border the furrow, the united pair thus completing conformably the apex of the rectilineal angle of the actinal interradial area which is bounded by the two adjacent furrows. The actinal surface of the plates is plane and presents no prominence or convexity. The armature of each plate consists of a marginal series of eight or nine short, subprismatic, roundly truncate spinelets, exactly similar to those on the adambulacral plates. Behind this on the actinal surface of the plate are five or six thick, coarse, subprismatic papillæ, the foremost three standing in a line parallel to the median suture, and this line is continued to the outer extremity of the plate by about half a dozen small, low, prismatic granules; the outermost three stand parallel to the marginal spines, and a few small granules extend from this point along the margin contingent with the adjacent adambulacral plate; and occasionally one or two stand in the intervening space between the line thus formed and the line of granules parallel to the furrow above noticed.

The actinal interradial areas are covered with a great number of small, regular, quadrangular intermediate plates. The largest are adjacent to the adambulacral plates; and these as well as the next two or three longitudinal series are a little broader than long, the breadth diminishing in each row away from the furrow; the remaining intermediate plates have the length and breadth subequal, and all diminish in size as they approach the margin, where some small and irregular plates are found. The plates fit close together, forming a compact pavement. The surface of the plates is covered with coarse, uniform, subprismatic granules, those forming the marginal series on each tabulum being a shade larger than the others, and always presenting a straight side to the margin, as if the outer edge of the whole series had been trimmed with a knife. The granules are closely placed, but do not touch one another. On a few of the plates is an excavate pedicellaria of similar character to those on the abactinal surface already described, but much larger and with broader jaws; the largest ones are nearest the mouth, and pedicellariæ generally are also of more frequent occurrence on the inner third of the area. Sometimes the pedicellariæ appear as if formed of two pedicellariæ closely juxtaposed, with the jaws either opening in the same plane or at an angle. In this case the pedicellarian apparatus of the plate has four jaws; in others there may be three jaws. The breadth of the jaws varies considerably, and there is no regularity in the orientation of the pedicellariæ. The pedicellariæ nearest the margin are much smaller, and nearly of the same character as those on the abactinal surface.

The anal aperture is subcentral, and is on the right posterior area of the dorso-central plate, when the madreporite is placed in the right anterior interradium.

The madreporiform body is rather small, subpolygonal in form, and flatly convex; it is situated at about one third of the distance from the centre to the margin. It is remark-

able for only showing convoluted striæ on the bevelled margins of the body, the whole of the central area being covered with very numerous small oblong pits.

Colour in alcohol, a bleached yellowish white, with a slight brownish shade.

Individual Variation.—In a rather smaller example than that described above, R = 56 mm., and from the same locality (Station 313), it is noteworthy that all the infero-marginal plates, excepting only the last two or three, have a well-developed oval naked space. In this specimen there is some irregularity both in the size and in the position of the large papilliform granules on the adambulacral plates which immediately succeed the furrow series, and sometimes only two are present.

Locational Variation.—A series of specimens from Station 311 are all much smaller in size than the type described, the largest measuring only R = 37 mm. In these the tips of the rays are slightly more definitely pointed, and all the infero-marginal plates have naked spaces, excepting only in some instances two or three plates at the tip. The naked spaces appear to be relatively larger in some of the smaller examples, but considerable variation is shown in the series in this respect: and I am therefore unable to say definitely that the size of this area diminishes with age, although I am disposed to think that such is the case. It is remarkable that none of the specimens from this locality (Station 311) have any pedicellariæ on the actinal surface. In the smallest example, which measures R = 26 mm., r = 15 mm., there are eleven supero-marginal plates, counting from the median interradial line to the extremity.

Localities.—Station 313. Near the Atlantic entrance to the Strait of Magellan. January 20, 1876. Lat. 52° 20′ 0″ S., long. 67° 39′ 0″ W. Depth 55 fathoms. Sand. Bottom temperature 47°·8 Fahr.; surface temperature 48°·2 Fahr.

Station 311. Off the entrance to Smyth Channel. January 11, 1876. Lat. 52° 45′ 30″ S., long. 73° 46′ 0″ W. Depth 245 fathoms. Blue mud. Bottom temperature 46°·0 Fahr.; surface temperature 50°·0 Fahr.

5. *Pentagonaster japonicus*, n. sp. (Pl. XLVI. figs. 1 and 2; Pl. XLIX. figs. 1 and 2).

Rays five. R = 68 mm., r = 50 mm. R = 1·36 r. The minor radius is thus in the proportion of about 73 per cent.

Body of large size. General form depressed and thin. Abactinal area slightly convex and capable of being more or less inflated, the inflation being greatest in the radial regions, and emphasised by a conspicuous but shallow sulcus which traverses the interradial lines, but terminates at a short distance from the centre. The interradial channels are of uniform breadth, well defined and smooth, their character and regularity suggesting—fancifully, of course—the appearance of a mark produced by the pressure of a heated cylinder. The marginal contour has the form of an almost regular pentagon, with the sides very slightly incurved, the incurvature being produced more by a slight prolongation

of the ray than by the regular curve of the side as a whole. Margin thick and vertical, equally rounded actinally and abactinally. Actinal area plane or slightly concave, undulating, more or less flexible, and capable of some inflation; a slight sulcus usually defined along the median interradial line.

The whole abactinal area is covered with small, regular, polygonal tabula, which diminish in size as they approach the margin (where they are very small); they are also smaller in the central region of the disk and along the edge of the interradial sulcus than in the median radial area and on the actual floor of the sulcus. The larger tabula in the radial areas, which are more or less elevated or paxilliform, are comparatively widely spaced, exposing the papulæ, of which there are about six round each tabulum, separated from one another by the stellate prolongations of the basal portion of the plates. The paxillæ consist of a hexagonal, rhomboid, or polygonal tabulum, slightly raised and faintly convex in the radial regions, where the paxillæ are widely spaced. The tabulum is covered with coarse, low, and almost truncate granules, and the margin is surrounded by a series of thin lamelliform papillæ or flattened granules, which have a striking appearance as compared with other species (see Pl. XLIX. fig. 1). A small excavate pedicellaria with two rather broad jaws and associated pit is present on some of the tabula, and appears to be always placed at the margin of the tabulum, some of the neighbouring granules being scooped away as it were for its reception.

The supero-marginal plates, which are seventeen in number, counting from the median interradial line to the extremity, form a well-defined and nearly uniformly broad border to the abactinal area. The plates near the interradial line have their length and breadth subequal, the length being perhaps slightly in excess; as they proceed along the ray, however, the length diminishes step by step, until at the extremity the breadth is fully twice as great as the length. The plates are distinctly tumid. The lateral surface of the plates is covered with very small, uniform, crowded granules, but on the abactinal area of the plate there is a large naked quadrangular space which occupies nearly the whole of that surface, being separated from the margin only by two (or rarely three) rows of the small granules. The majority of the plates bear one, or occasionally two, small pedicellariæ placed at the edge of the naked space.

The infero-marginal plates correspond to the superior series, and are, like them, covered with small crowded granules, excepting, however, a small circular area on the actinal surface of each plate, which is naked. Nearly all the infero-marginal plates bear one of the small excavate pedicellariæ similar to those on the supero-marginal plates: a few plates bear two. The pedicellariæ appear to be invariably placed close to one of the margins of the plate.

The adambulacral plates are slightly broader than long, and their armature consists of a marginal series of six short, subequal spinelets, excepting the adoral spine of the series, which is smaller. The spinelets are thick and subprismatic or quadrangular in section, and have a

roundly truncate tip; their base-line forms a slight curve, trending rather obliquely adorally. At a short distance behind the furrow series are three or four low, prismatic, laterally elongate granules, which form a slightly arched or straight series, traversing the plate slightly obliquely, the aboral end of the series being nearest the marginal or furrow series of spinelets. The remainder of the plate external to these is covered with large, low, subprismatic granules, which may form two or three subregular parallel lines but seldom definitely regular. Normally each adambulacral plate bears a single large two-valved excavate pedicellaria which is usually placed at the adoral extremity of the first series of granules behind the furrow series, although occasionally it is found immediately behind this second series, but always adjacent to the adoral margin of the plate. Rarely near the mouth these pedicellariæ may be rather irregular in construction, and formed of three or more valves.

The mouth-plates are elongate and triangular, slightly truncate exteriorly, and with the free margin of each plate forming a straight line in continuation of the series of adambulacral plates, the united pair completing exactly the apex of the rectilineal angle of the actinal interradial area, bounded by the two adjacent furrows. The actinal surface of the plates is plane or very faintly convex. The armature of each plate consists of a marginal series of nine or ten short, prismatic, roundly truncate spinelets, exactly similar to those upon the adambulacral plates, but which increase slightly in size as they approach the inner extremity of the mouth-plate. On the actinal surface of the plate a row of about seven or eight large, low, irregular-shaped, prismatic granules runs parallel to the median suture. The innermost two of this series might also be reckoned as parallel to the marginal series, and three or four similar granules continue a line in this direction. Two or three small prismatic granules occupy the angular area between the two main series above described, and along the base-line of this area, which abuts on the first free adambulacral plate, is a straight series of similar granules.

The actinal interradial areas are paved with a great number of small, normally quadrangular, but occasionally polygonal, intermediate plates, which fit close together and form a compact pavement. The largest are adjacent to the adambulacral plates, and these as well as the next one or two series are a little broader than long, the breadth of each row diminishing as it recedes from the furrow. The remaining intermediate plates have the length and breadth approximately equal, or they may be irregular and trapezoid in shape. All the plates diminish in size as they approach the margin, the plates at the extreme edge of the area adjacent to the infero-marginal plates being very small. The surface of the plates is covered with small, low, uniform granules, which are arranged in straight series along the margins of the plates, but show no definite order within this boundary. In the row adjacent to the adambulacral plates nearly every intermediate plate bears a small excavate pedicellaria with two broad, low, truncate, lamelliform valves, a little broader than high. Occasionally two pedicellariæ are present. Similar pedicellariæ are also present on a number of plates in the neighbourhood of the median interradial line

and in an ill-defined region parallel to, and a little removed from, the infero-marginal plates. These pedicellariæ on the intermediate plates are of nearly uniform size throughout, and there is no regularity in their orientation.

The anal orifice is slightly excentric, and is surrounded by rather larger plates than in the central region generally.

The madreporiform body, which is rather small and polygonal in form, is situated at about one-third of the distance from the centre to the margin. It is marked with fine, regular, sharply convoluted, centrifugally radiating striations.

Colour in alcohol, a warm shade of light brown.

Locality.—Station 232. South of Yeddo (Japan). May 12, 1875. Lat. 35° 11′ 0″ N., long. 139° 28′ 0″ E. Depth 345 fathoms. Green mud. Bottom temperature 41°·1 Fahr.; surface temperature 64°·2 Fahr.

Remarks.—*Pentagonaster japonicus* is distinguished from *Pentagonaster patagonicus*, to which it is most nearly allied, by the more regular pentagonal form, the sides being less curved, and the rays less produced. The general granulation is finer. The structure of the paxillæ and the armature of the adambulacral plates are characteristic, as well as the presence of numerous pedicellariæ.

6. *Pentagonaster lepidus*, n. sp. (Pl. LVII. figs. 1–4).

Body pentagonal, with the sides slightly incurved and the extremities of the rays rather obtuse or rounded. $R = 7{\cdot}5$ mm.; $r = 5$ mm. $R = 1{\cdot}5\ r$.

General form depressed and thin. Margins rounded and slightly bevelled abactinally. Abactinal surface feebly inflated along the median radial line; extremities of the rays slightly turned upward.

The abactinal and marginal plates are covered with small, uniform, papilliform spinelets, distinctly clavate and well spaced; those on the infero-marginal plates being longer than the others. The actinal intermediate plates are similarly covered with small spinelets, which are tapering.

The papilliform spinelets on the abactinal plates simulate paxillæ in their posture and grouping, and the groups are tolerably spaced. A distinct median series traverses the radial line, and very little variation in size is noticeable throughout the area.

The supero-marginal plates are nine in number on each side of the pentagon, and there is consequently an odd plate in the median interradial line. This plate is of the same shape and size as those on each side, its length and breadth being about equal. The length of the succeeding plates diminishes slightly as they approach the extremity. The odd terminal plate is rounded and patella-like.

The infero-marginal plates bear longer spinelets than the superior series, and these are confined to the lateral face. The surface which is presented to the actinal area of the

starfish bears only very small and slightly tapering spinelets similar to those on the actinal intermediate plates. The actinal intermediate plates are comparatively large, but are scarcely definable. They bear numerous small, uniform, well-spaced, tapering spinelets which present no definite order of arrangement, but whose presence gives a decidedly hispid appearance to the actinal surface; all the spinelets are slightly inclined towards the margin of the starfish.

The adambulacral plates have their length and breadth nearly equal. Their armature consists of a furrow series of three or four short, tapering spinelets, the fourth spinelet, when present, being adoral and very small. The series is slightly oblique in position, the adoral end being more remote from the furrow than the aboral. On the actinal surface of the plate is a series of about three spines, normally forming a slightly oblique line parallel to the furrow series, but often irregular. These spinelets are rather more robust than the furrow series and the aboral one is usually the largest, especially on the outer part of the ray, where the difference is very striking.

The mouth-plates are flat and inconspicuous. Their armature consists of a marginal series of about four short, tapering spinelets rather wide apart, similar to those on the furrow margin of the adambulacral plates; and on the actinal surface of the plate are four spinelets near the outer margin remote from the mouth; and in the intermediate space two or three secondary mouth-spines, the innermost being robust and larger than any other spinelets on the actinal surface.

The madreporiform body is hidden. I have not detected the presence of any pedicellariæ.

Colour in alcohol, a bleached white, with a dark umber shade over part of the abactinal area, perhaps caused by the presence of mud beneath the clavate papillæ or spinelets of the abactinal plates.

Locality.—Station 78. Between the islands of San Miguel and Santa Maria (Azores). July 10, 1873. Lat. 37° 26′ 0″ N., long. 25° 13′ 0″ W. Depth 1000 fathoms. Volcanic mud. Surface temperature 71°·0 Fahr.

Remarks.—There is little doubt in my mind that this is a young and immature form; and as to its true generic position I have felt much uncertainty. Its affinities appear to be nearest to *Pentagonaster*, and it has also some resemblance to *Astrogonium*. Notwithstanding its very hispid character and several other structural peculiarities, I have placed it with the former group, at least until other material is available for settling the question more satisfactorily. Of course it is quite possible that this may prove to be the young of one of the species recently described by Perrier[1] from this area of the Atlantic, but I am unable to hazard even a suggestion. I am inclined to think from its general character, as well as from the presence of the odd interradial marginal plate, that the present form is distinct, and I have accordingly given it a name. *Pentagonaster lepidus* is quite devoid

[1] *Ann. Sci. Nat.* (Zool.), 1885, t. xix., Art. No. 8, pp. 34–36.

of the spiniform prolongation of the mouth-plates which is developed in *Gnathaster*, at even an earlier stage than this. It is to be remarked that *Gnathaster* is much more hispid in the young stage than in the adult, a character probably common to other forms of the Pentagonasteridæ.

7. *Pentagonaster arcuatus*, n. sp. (Pl. LII. figs. 1 and 2; Pl. XVIII. figs. 5 and 6).

Rays five. R = 45 mm.; $r = 23{\cdot}5$ mm. $R = 1{\cdot}93\ r$. The minor radius is thus in the proportion of 52·2 per cent.

General form flat, but moderately thick. Marginal contour stellato-pentagonal, with the radial angles produced and tapering to an acute extremity, which is slightly turned upward. Interbrachial arcs widely rounded. Margins equally rounded abactinally and actinally. Abactinal area not elevated above the level of the marginal plates; slight depressions are present in the interradial areas near the margin, which are probably indicative of a limited capability of inflation. Actinal area subplane, with small well-defined depressions external to the mouth-plates.

The abactinal area is covered with small, subcircular plates, closely placed, united by short, narrow prolongations, which leave interspaces for comparatively large papulæ in the radial regions. The abactinal plates extend to the tip of the ray, two or more series separating the outermost supero-marginal plates from the corresponding plates on the other side of the ray. Seen from above the abactinal plates have a strikingly paxilliform appearance, when their granulation is intact; the subcircular tabulum is surrounded by a marginal series of small uniform, slightly elongate granules, moderately spaced, and so placed that they appear to radiate slightly apart. Within this ring are several small hemispherical granules, the majority of which are larger than the marginal series, but are in no sense elongate. A small valvate pedicellaria formed by two contingent granules is present on the tabulum of a few of the paxillæ, but these organs are of rare occurrence. The plates on the outer part of the ray and those adjacent to the margin throughout are devoid of stellate prolongations, and appear to have more or less of an imbricating character.

The supero-marginal plates, which are seventeen or eighteen in number, counting from the median interradial line to the extremity, form a well-defined border to the abactinal area, which diminishes in breadth towards the extremity of the rays. The plates near the interradial line have their breadth rather greater than their length, and the length distinctly increases in a few of the succeeding plates, and then diminishes on the outer half of the ray. The surface of the plate, which is slightly convex in the transverse direction, is covered with rather large, well-spaced, hemispherical granules, those which bound the margin being rather smaller than the others, and regularly disposed in lineal series. The odd terminal plate is very small.

The infero-marginal plates correspond to the superior series in the neighbourhood of the median interradial line, but alternate with them along the rest of the ray. They are covered with precisely similar granules. I have detected no pedicellariæ on either series of marginal plates.

The adambulacral plates are slightly broader than long, and their armature consists of three regular series of spinelets. In the furrow series are seven moderately elongate, prismatic spinelets, compressed transversely, with obtusely rounded tips, subequal in length excepting one or two at the adoral end of the series which are rather shorter; these spinelets radiate very slightly apart, but to such a small degree that their disposition is almost that of a compact comb. The second series, which is placed on the actinal surface of the plate, consists of five quadrangular prismatic spinelets, which taper slightly, and are shorter but more robust than the furrow series. The adoral spinelet of this series is usually placed rather further back on the plate than the others, a circumstance which causes this series to have the appearance of a slightly oblique position. The third series is close to the external margin of the plate, and consists of four or five low, equal, granuliform spinelets, or spiniform granules, much shorter than the median series just described. The outer spinelet at each end of the series is often accompanied by another placed close behind, and this is sometimes modified into a pedicellaria. Sometimes the whole line may be doubled on the outer part of the ray. The three distinct series of spinelets above described are comparatively widely spaced apart.

The mouth-plates are small and inconspicuous. Their armature consists of a marginal series on each plate of ten to thirteen powerful representatives of the marginal spinelets on the adambulacral plates, which increase in size as they approach the mouth. On the actinal surface of the plate is a lineal series of about five short, robust, prismatic secondary spinelets, and on the outer part of the plate are a few prismatic granules.

The actinal interradial areas are large, and extend far along the ray. The intermediate plates have, in consequence of their mode of granulation, a very paxilliform appearance, their armature consisting of a marginal series of slightly elongate subprismatic granules surrounding several larger hemispherical granules, all of which are well spaced.

The madreporiform body is situated near the centre, its inner margin being less than one-fourth of the distance from the centre to the margin. It is rather large and subcircular in outline, and its surface is marked with fine striations, which are much convoluted in the central region.

Colour in alcohol, a light shade of umber brown.

Locality.—Station 232. South of Yeddo, Japan. May 12, 1875. Lat. 35° 11′ 0″ N., long. 139° 28′ 0″ E. Depth 345 fathoms. Green mud. Bottom temperature 41°·1 Fahr.; surface temperature 64°·2 Fahr.

Remarks.—This species is distinct from any other *Pentagonaster* with which I am

acquainted, and is readily distinguished from all the Pacific forms at present known. Its general character points to some alliance with *Pentagonaster intermedius*, of which *Pentagonaster arcuatus* is perhaps the Pacific representative. In some of its structural details *Pentagonaster arcuatus* resembles forms grouped in the genus *Nymphaster*, of which I was at first disposed to consider it an aberrant species. I am still in some doubt as to whether this form is correctly referred to the genus *Pentagonaster*, but with only a single example for study, that course appeared to me the most justifiable.

Genus *Calliaster*, Gray.

Calliaster, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 280.

This genus was established by Gray in 1840, but was merged by Perrier[1] in 1876 in the genus *Pentagonaster*, with doubtful subgeneric rank. A fine series of well-preserved specimens, comprising the types of Gray's species, exist in the British Museum; and after a careful study of these, together with the new form, I consider that the genus established by Gray should be maintained. The characters of the adambulacral armature, of the actinal intermediate plates, and of the general facies of the form appear to me to be worthy of recognition, at least until more is known of the internal anatomy of the various members of the Pentagonasteridæ, and of the true taxonomic value of the correlated external structures.

Chorology of the Genus Calliaster.

α. *Geographical distribution*:—

Atlantic: One species between the parallels of 30° and 40° S.
Calliaster baccatus off the Cape of Good Hope.

Pacific: One species between the parallels of 30° and 40° N.
Calliaster childreni off the coast of Japan.

β. *Bathymetrical range*: Appears to be confined to the Littoral zone: 18 fathoms is the greatest depth recorded by the Challenger.

γ. *Nature of the Sea-bottom*: Not recorded.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Calliaster baccatus . . .	Atlantic.	5 to 18	...
Calliaster childreni . . .	Pacific.	...	...

[1] Révis. Stell. Mus., p. 215 (*Archives de Zool. expér.*, 1876, t. v. p. 31).

1. *Calliaster baccatus*, n. sp. (Pl. LVI. figs. 1–4).

Rays five. R = 44 mm.; r = 18 mm. Breadth of a ray at the fourth marginal plate, 10·5 mm.

Rays short and of almost uniform breadth throughout after the basal expansion is passed; extremities obtuse. Interbrachial arcs widely rounded. Lateral walls rather thick and vertical. Abactinal area more or less inflated.

The abactinal area is covered with rather large, irregularly circular tabula, the medio-radial series and the primary apical plates being the largest, and all diminishing in size as they recede from the centre. Each plate bears on its tabulum a large robust, thimble-shaped granule or stumpy spinelet, or, very rarely, two smaller ones may be present. The margin of the tabulum is surrounded by a ring of comparatively large and somewhat irregular bead-like granules of low elevation, somewhat flattened from the outside, having the appearance of being skin-covered, and consequently rather badly defined. They suggest in a certain degree the granules which bound the scrobicular ring around the primary tubercles of most of the Cidaridæ. In the interspaces between the plates small papulæ may be seen.

The marginal plates are massive, and each is distinctly tumid, especially in the supero-marginal series. The supero-marginal plates are nine in number, counting from the median interradial line to the extremity, and exclusive of the odd terminal plate. They form a broad conspicuous border to the disk and rays, the breadth of which increases slightly as it approaches the extremity. The plates adjacent to the median interradial line have the length subequal to, or slightly greater than, the breadth as seen from above, but at the extremity of the ray these proportions are reversed, and the breadth is distinctly in excess of the length. The penultimate plate is the largest of the series, and touches the corresponding plate of the other side of the ray in the median line. The last paired plate is small and wedge-shaped, and the odd terminal plate is small and more or less tubercle-like. The surface of the plates is perfectly smooth, and their margin is surrounded by a single series of rather large, flattened, bead-like granules. Each plate, excepting the innermost, bears a single knob-like tubercle or large stumpy granule on the lateral wall at its union with the abactinal area, and close to the aboral margin of the plate. The third and fourth plates from the median interradial line also bear a similar tubercle close to their inner margin, adjacent to the paxillar area; and in one instance the fifth plate is similarly furnished. The last three plates may bear one or two smaller granules near their aboral margin, and the terminal plate may also bear from one to three granules at its extremity.

The infero-marginal plates are ten in number. They are similar in character to the superior series, being smooth, and margined by a single series of bead-like granules; and they bear two or three knob-like granules near their aboral margin at the junction of the actinal and lateral areas. On the plates at the base of the rays there is a tendency for

these knobs to form a small lineal series slightly oblique in relation to the aboral margin of the plate.

The adambulacral plates are considerably broader than long. Their armature consists of a furrow series of three short, robust, slightly tapering but obtusely tipped spinelets, radiating slightly apart; and the median spinelet is rather larger than its companions. On the actinal surface of the plate are two thick, short, robust, obtuse, stumpy spinelets; and on the inner half of the ray frequently three, placed one behind the other. These are so large that they leave no room on the plate for anything but an occasional and irregularly placed granule. The margin of the plate is surrounded by a single series of large bead-like granules distinctly spaced.

The actinal interradial areas extend as far as the fourth infero-marginal plate, and are covered with large plates or tabula, which resemble those on the abactinal area. The tabula are margined by bead-like granules, the separate plates being thus distinctly marked, and each plate bears from one to three short, robust, obtuse, papilliform granules or spinelets similar to those on the actinal surface of the adambulacral plates, all increasing slightly in size as they approach the mouth.

The mouth-plates are large but not prominent. Their armature consists of a marginal series of four spines on each plate, which increase in size as they advance inward. There is thus a pair of large, cylindrical, obtusely tipped spines at each mouth-angle directed over and closing the actinostome. On the actinal surface of the plates are two large, robust, cylindrical spinelets, slightly larger than any of the other large obtuse spinelets on the actinal surface, and behind these are two granules forming with the two secondary or superficial spines just mentioned a lineal series.

The tube-feet have large sucker disks; and the ambulacral furrows are narrow and closed over by the armature of the adambulacral plates.

The anal aperture is subcentral and margined by one or two rings of granules, the inner series small, the outer larger and more irregular.

The madreporiform body is conspicuous and situated about midway between the centre and the margin. Its surface is slightly convex and is marked with fine striation-furrows, which are much convoluted and meandriform.

Colour in alcohol, a bleached ashy or yellowish white.

Locality.—Simon's Bay, Cape of Good Hope. Depth 5 to 18 fathoms.

Remarks.—This species is readily distinguished from *Calliaster childreni*, Gray, the only other species of *Calliaster* at present known, by the obtuse and non-tapering rays, as well as by the less tumid supero-marginal plates, which distinctly increase in breadth as they approach the extremity, whilst in *Calliaster childreni* they slightly diminish. *Calliaster baccatus* is further characterised by the more numerous spines on the abactinal plates, which are more stumpy, as well as by the much coarser and peculiar bead-like granules that surround the tabula. In *Calliaster childreni* only the medio-radial series of tabula

and a few in the central region bear spines, whereas in the present form all are normally so furnished. On the actinal surface also the spines are similarly more numerous in *Calliaster baccatus*. The adambulacral armature in the two forms is strikingly different; in *Calliaster childreni* the furrow series of spinelets being seven or eight in number, very small and equal; but in the present form there are three only, which are large and unequal. Other differences occur in minor points of ornamentation, &c., to which it is unnecessary to refer in detail.

Genus *Chitonaster*, Sladen.

Chitonaster, Sladen in Narr. Chall. Exp., 1885, vol. i. p. 614.

Marginal contour stellate, with a rigid convex disk, and short, tapering, rounded rays. Abactinal area high and inflated over the disk.

Abactinal area covered with closely-fitting hexagonal, or slightly rounded, plates overlaid with a uniform layer of membrane. Each bearing a short obtuse spinelet or elongate tubercle.

Marginal plates large and covered with membrane. The superior and inferior series subequal, the latter being rather broader. The supero-marginal plates normally bear two short, obtuse, cylindrical spinelets, standing one above the other on the median transverse line of the plate. The infero-marginal plates are similar in form and character, and each bears two or three similar spinelets, also arranged in line transverse to the axis of the ray.

Adambulacral armature consisting of three large, isolated, cylindrical, obtuse spinelets, which form a line at right angles to the furrow.

Actinal intermediate areas small, confined to the region of the disk, and accommodating very few intermediate plates.

Madreporiform body small, situated nearer the margin than the centre of the disk.

Anal aperture subcentral.

No pedicellariæ present.

Remarks.—This genus is distinct from all known forms, and is remarkable not only for its structure, but also on account of the great depth at which it occurs. The general form and the character of the plating appear to justify the inclusion of *Chitonaster* in the Pentagonasteridæ, notwithstanding the fact that the family contains no genus with which a direct alliance can be established. This circumstance is, however, not so surprising as would at first appear, when it is borne in mind how very few members of the Pentagonasteridæ occur in deep water.

Unfortunately only a single example of this interesting starfish was collected by the Challenger: the following remarks are therefore necessarily limited entirely to external characters, as I consider it undesirable to mutilate this unique specimen.

Chorology of the Genus Chitonaster.

a. Geographical distribution:—

Southern Ocean: One species between the parallels of 60° and 70° S.

Chitonaster cataphractus, in the neighbourhood of the pack ice of the Antarctic Circle, near the meridian of 95° E. longitude.

β. Bathymetrical range: 1975 fathoms.

γ. Nature of the Sea-bottom: Diatom ooze.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Chitonaster cataphractus .	Southern Ocean.	1975	Diatom ooze.

1. *Chitonaster cataphractus*, n. sp. (Pl. LXXIII., figs. 1–3).

Rays five. R = 16·5 mm.; $r = 5$ mm. $R > 3r$. Breadth of a ray between the second and third infero-marginal plates, 4·75 mm.

General form stellate. Rays well produced and tapering from the base to the extremity. Abactinal area of the disk convex and almost hemispherical as seen in profile, that of the rays rounded and forming with the lateral wall a uniform curvature. Actinal area subplane.

The abactinal area is more or less rigid and entirely covered with closely-fitting hexagonal, or perhaps in places partially rounded, plates overlaid with a uniform layer of membrane, which renders it difficult to define exactly the outline of all the plates. Each plate bears one, and occasionally two or even three, short, robust, cylindrical, obtuse spinelets or elongate tubercles, uniform and equal throughout, the membrane mounting the base, but becoming so thin on the upper part that it is scarcely perceptible. No definite order of arrangement of the plates is distinguishable, but on the outer part of the ray only a single series of abactinal plates separates the supero-marginal plates of the two sides of a ray; and these extend uninterruptedly to the tip and are comparatively large. Occasionally a small granule is present on the plates, usually near the edge. I have failed to detect the presence of any trace of papulæ.

The supero-marginal plates, which are thirteen in number, counting from the median interradial line to the extremity, have the height (or breadth) greater than the length, and are slightly arched upon the abactinal surface in conformity with the rotundity of the ray. Each plate bears normally two short, obtuse, cylindrical spinelets or tubercles, similar to those on the abactinal plates, placed one above the other, that is to say along

the median line of height at right angles to the direction of the axis of the ray. Sometimes only one spinelet is present, and this usually occurs in the interbrachial arc; and sometimes a much smaller tubercle or granule may be present in addition to the two large ones above described, and this may stand either by the side of the upper spinelet or above it, in the latter case forming a lineal series of three along the median transverse line of the plate.

The infero-marginal plates are similar to the superior series but are not all regularly correspondent, and their breadth is rather greater than that of the latter plates. Each plate bears two or three spinelets or elongate tubercles, similar to those above described, placed in lineal series along the median transverse line of the plate; often one or two of these tubercles are much smaller. At the extremity of the ray the infero-marginal plates are smaller than the superior series, and only bear one spinelet. The surface of the marginal plates is slightly convex in the median transverse line, and the character is more or less emphasised by the membrane mounting the base of the spinelets.

The adambulacral plates are large and broader than long. Their armature consists of three large, cylindrical, obtuse spinelets, which form a transverse series along the median line of the plate at right angles to the furrow. The spinelet on the furrow margin and the middle one are subequal and much longer than any of the other spinelets on the animal; the outer spinelet is smaller. These spinelets radiate slightly apart. Occasionally there is a second and smaller spinelet on the furrow margin on the adoral side of the furrow spine proper, and placed somewhat obliquely in relation to it. Occasionally there may be an additional small spinelet at the outer end of the transverse series.

The mouth-plates are small and present no actinal prominence. Their armature consists of three spinelets on the free margin. The innermost spine is large and cylindrical, the second is smaller and slightly tapering, the third is larger than the second and cylindrical, and should perhaps be counted with the superficial series. On the actinal surface of the plate are two much smaller spinelets, the outermost smallest, forming with the outer marginal spine a line of three, corresponding to the three spines on the adambulacral plates. No other spines are present on the plates. The plates do not appear to meet in the median suture, but no superficial indication of this is present, as the whole surface is covered with the same uniform layer of membrane as the other parts of the starfish.

The actinal interradial areas are very small. Not more than four or six intermediate plates are present in each, and each of these bears a small tubercle similar to, but smaller than those on the abactinal plates. Consequently all except the innermost three or four adambulacral plates are contingent on the infero-marginal plates.

The anal aperture, which is subcentral and slightly excentric, is conspicuous and margined by a number of robust elongate granules.

The madreporiform body is small and has very coarse striæ, which, in consequence of their disposition, give the organ almost the appearance of a group of coarse granules. It

is situated nearer the margin than the centre of the disk, at the top of the lateral wall in the interbrachial arc, and is surrounded by the spinelets borne on the adjacent abactinal plates.

No pedicellariæ of any kind are present.

The ambulacral tube-feet have large fleshy disks.

Colour in alcohol, an ashy grey.

Locality.—Station 156. In the neighbourhood of the pack ice, near the Antarctic Circle. February 26, 1874. Lat. 62° 26′ 0″ S.; long. 95° 44′ 0″ E. Depth 1975 fathoms. Diatom ooze. Bottom temperature 32·1° Fahr.; surface temperature 37·2° Fahr.

Genus *Gnathaster*, n. gen.

It is not without great reluctance that I have proposed a new generic name for the present small group of species. I had hoped in the first instance to have limited the term *Astrogonium* in such a way as to have served for their reception, since all the species except the new ones have at various times been ranked in that genus. Unfortunately, however, they do not comprise a single species referred by Müller and Troschel to *their* genus; and on carefully studying the diagnosis given in the System der Asteriden (p. 52) it will be seen that that diagnosis could in no way be amended so as to admit of the reception of the forms now under consideration, without such a radical alteration as would really take away from it the only characters upon which its original recognition depended.

On referring to the series of species grouped by Müller and Troschel in the genus *Astrogonium*, it will be apparent that all of them, excepting the form originally described by Gray [1] under the name of *Pentagonaster pulchellus*, are referrible to the older genera *Pentagonaster* of Linck and *Hippasteria* of Gray. It is therefore to this form, *Pentagonaster pulchellus*, Gray, and its subsequently described allies, that the generic appellation of *Astrogonium* should now be applied, if the name is retained at all.

Perrier [2] has recently expressed the opinion that this type (*Pentagonaster pulchellus*, Gray), together with a small assemblage of allied species, is worthy of independent generic recognition. This view appears to me just, and based on the presence of characters the morphological significance of which had hitherto been overlooked. As a generic name for this group, Perrier has restored that of *Stephanaster* of Ayres,[3] on the ground that *Stephanaster elegans*, Ayres, is synonymous with *Pentagonaster pulchellus*, Gray, or in other words, that the form described by Gray in 1840, under the name of *Pentagonaster pulchellus*, was redescribed by Ayres in 1851 under the name of *Stephanaster elegans*, on the supposition that it was a genus and species new to science.

With this selection of a name for the group in question I am unable to agree, for in

[1] *Ann. and Mag. Nat. Hist.*, 1840, vol. vi. p. 280.

[2] *Ann. Sci. Nat.* (Zool.), 1885, t. xix., Art. No. 8, p. 30.

[3] *Proc. Boston Soc. Nat. Hist.*, 1851, vol. iv. p. 118.

my judgment the name *Astrogonium*, Müller and Troschel, 1842, has, for the reasons above stated, a ten years' priority, irrespective altogether of usage, which ought not to be set aside in favour of *Stephanaster*, and it is therefore to this group only, in my opinion, that the name *Astrogonium* can logically be applied.

The small series of species which have now to be considered are readily distinguished by certain structural characters from all the other Pentagonasteridæ. I propose to group them together under the generic name of *Gnathaster*, and define the genus by the following characters:—

(1.) Plates of the abactinal area more or less truly paxilliform.
(2.) Tegumentary developments more or less spiniform.
(3.) Mouth-plates with a prominent keel developed into an elongate spiniform process.
(4.) An odd interradial marginal plate present in most, if not in all, cases.

In this genus I include the species previously described under the following names:—

Goniodiscus singularis, Müller and Troschel.
Astrogonium miliare, Gray.
Astrogonium paxillosum, Gray.
Pentagonaster dilatatus, Perrier.
Astrogonium meridionale, Smith.
Calliderma grayi, Bell.

To these are added two new species discovered by the Challenger.

Chorology of the Genus Gnathaster.

a. Geographical distribution:—

Atlantic: Three species between the parallels of 50° and 60° S.
**Gnathaster pilulatus*, near the Atlantic entrance to the Strait of Magellan. *Gnathaster grayi* and *Gnathaster paxillosus*, at Sandy Point in the Strait of Magellan. The latter species is also found in the Eastern Archipelago off the coast of North Australia.

Pacific: Three species between the parallels of 30° and 55° S.
Gnathaster singularis, off the west coast of South America. *Gnathaster miliaris* and *Gnathaster dilatatus*, off New Zealand.

Eastern Archipelago: One species between the parallels of 5° and 15° S.
Gnathaster paxillosus, from Port Essington, off North Australia. This species also occurs in the Strait of Magellan (*fide* Bell[1]).

Southern Ocean: Two species between the parallels of 40° and 60° S.
**Gnathaster meridionalis* and **Gnathaster elongatus*, off Marion Island, Kerguelen Island, and Heard Island.

The species collected by the Challenger are indicated in the foregoing list by an asterisk.

[1] *Proc. Zool. Soc. Lond.*, 1881, p. 97.

β. Bathymetrical range: 5 to 150 fathoms.

Gnathaster meridionalis ranges from 5 to 150 fathoms, and *Gnathaster elongatus* from 50 to 150 fathoms. *Gnathaster pilulatus* is found in 55 fathoms. *Gnathaster singularis* is recorded from shallow water to 30 fathoms, *Gnathaster paxillosus* and *Gnathaster grayi* from 9 to 10 fathoms.

Greatest range of one species: *Gnathaster meridionalis*, 5 to 150 fathoms.

γ. Nature of the Sea-bottom: The character of the ground is only recorded in the case of the species above mentioned. *Gnathaster meridionalis* and *Gnathaster elongatus* are found on volcanic mud and coarse gravel (the latter in 150 fathoms). *Gnathaster pilulatus* inhabits a sandy bottom. *Gnathaster singularis* occurs on rock, kelp, and mud. *Gnathaster paxillosus* and *Gnathaster grayi* on sand.

Chorological Synopsis of the Species herein mentioned.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Gnathaster elongatus . . .	Southern.	50 to 150	Volcanic mud; coarse gravel.
Gnathaster meridionalis . .	Southern.	5 to 150	Volcanic mud; coarse gravel.
Gnathaster pilulatus . . .	Atlantic.	55	Sand.

1. *Gnathaster meridionalis*, Smith, sp. (Pl. XLVII. figs. 1 and 2; Pl. XLIX. figs. 11 and 12).

Astrogonium meridionale, Smith, 1876, Ann. and Mag. Nat. Hist., ser. 4, vol. xvii. p. 109.
Pentagonaster meridionalis, Smith, 1879, Phil. Trans., Zool. Kerguelen Island, vol. clxviii. p. 276, pl. xvi. figs. 6, 6*a*.

Localities.—Station 145. Off Marion Island. December 26, 1873. Depth 50 fathoms.

Station 149D. Royal Sound, Kerguelen Island. January 20, 1874. Depth 28 fathoms.

Station 149H. Off Cumberland Bay, Kerguelen Island. January 29, 1874. Depth 127 fathoms. The bottom deposit at all Stations in the neighbourhood of Kerguelen is a greenish volcanic mud.

Station 150. Between Kerguelen Island and Heard Island. February 2, 1874. Lat. 52° 4′ 0″ S., long. 71° 22′ 0″ E. Depth 150 fathoms. Coarse gravel. Bottom temperature 35°·2 Fahr.; surface temperature 37°·5 Fahr.

Station 151. Off Heard Island. February 7, 1874. Lat. 52° 59′ 30″ S., long. 73° 33′ 30″ E. Depth 75 fathoms. Volcanic mud. Surface temperature 36°·2 Fahr.

Remarks.—A fine series of this species was obtained off Kerguelen, Marion, and Heard

Islands, those from the two last-named localities being nearly all young forms. The majority of the examples from Kerguelen are considerably larger than the type form described by Mr. Smith, which was also collected at Kerguelen, during the sojourn of the Transit of Venus Expedition in 1875. The largest specimen dredged by the Challenger measures R = 68–70 mm.; $r = 27$ mm.; another example, R = 60 mm.; $r = 23$ mm. I have figured one of these examples.

I have failed to detect any pedicellariæ in this species, although it is distinctly stated in Mr. Smith's diagnosis that numerous large ones occur in the interspaces between the paxillæ on the abactinal area. Numerous large and conspicuous papulæ are present in all these interspaces, and I venture to suggest with little hesitation that these are the organs referred to, the word "pedicellariis" having probably slipped in inadvertently.

Young Phase.—The small examples taken off Marion and Heard Islands exhibit so unmistakably the characters of the adult, that I feel little or no hesitation in assigning them to this species, notwithstanding their being found in association with *Gnathaster elongatus*. It is to be confessed, however, that I should have shrunk from expressing an opinion so definitely if the young of *Gnathaster elongatus* had been unknown, but fortunately small examples of that species were found at Marion Island and Kerguelen, which on their part resemble so characteristically the adult form of their species, and are so readily distinguishable from the young examples of the same size of *Gnathaster meridionalis*, as to place the question almost beyond doubt. I have given figures of the young of both species, see Pl. XIX. and Pl. XLVIII. The adult forms are drawn on Pl. XLVII. and Pl. XLVIII.

2. *Gnathaster elongatus*, n. sp. (Pl. XLVIII. figs. 1–4; Pl. XLIX. figs. 5–10; Pl. XIX. figs. 5 and 6).

Rays five. R = 56 mm.; $r = 16{\cdot}5$ mm. (Another example, R = 62 mm.; $r = 17$ mm.) R = $3{\cdot}5\ r$ approximately. Breadth of a ray between the second and third superomarginal plates, 14·5 mm.

Rays long, narrow throughout and tapering for the genus. General form subdepressed. Abactinal area capable of slight inflation, often producing the effect of carination along the ray. Actinal area subconvex, especially apparent along the ray. Margin thin but rounded outwardly. Interbrachial arcs wide and open, but often with a slight tendency to become angular at the summit of the arc.

The whole abactinal paxillar area is covered with low and rather distinctly spaced pseudo-paxillæ, leaving small spaces for the protrusion of the papulæ. The crown or tabulum of the paxilla is subcircular and bears nine to twelve or more very short papilliform granules, of which one to three are central; these are coarse, subprismatic, roundly truncate, all perfectly uniform in height, size, and character, and are not specially crowded

upon one another. The paxillæ along the sides of the rays are arranged in regular obliquely transverse lines, seven or eight being present in each series near the base of the ray. The paxillæ in the central area of the disk and in the narrow median strip along the rays are not included in this arrangement. A certain longitudinal disposition, though scarcely to be described as subregular, occurs along the ray.

The supero-marginal plates are small and subrhomboidal in form, the sutures between adjacent plates forming obliquely transverse lines, which trend from within outward and slightly backward. The supero-marginal plates are thirty in number counting from the median interradial line to the extremity. There is a small odd triangular plate in the median interradial line which does not reach the margin. The innermost marginal plates have the breadth slightly in excess of the length, but along the greater part of the ray the length is slightly greater than the breadth. At the extremity the breadth of the plates is greater than the length and owing to their posture on the ray the height is the predominant dimension. On the inner part and until quite near the extremity the plates are low and flat-lying, with the height less than the other dimensions. The surface of the plates is covered with numerous comparatively large, coarse, low, subprismatic, truncate granules all of uniform size, not specially crowded and superficially similar in all respects to the granules on the paxillæ. The divisions between succeeding plates are well marked. Usually two of the obliquely transverse series of paxillæ are opposite each supero-marginal plate.

The infero-marginal plates correspond in length to the superior series, and are confined almost entirely to the lateral wall, curving very slightly towards the actinal surface, very little of their surface being seen when the starfish is viewed from below; though the amount presented may vary slightly according to the inflation of the ray and the consequent posture of the marginal plates. When the lateral wall of the ray is placed in the direct line of view, the height of the plate is seen to be rather greater than the length on the inner part of the ray and at the extremity, but rather less than the length midway along the ray. They are covered with precisely similar granules to those on the supero-marginal plates. There is also an odd infero-marginal plate in the median interradial line, narrow and wedge-shaped, its outline being an isosceles triangle, whilst that of the odd supero-marginal plate is an equilateral one.

The adambulacral plates are short and broad, and their armature consists on the inner half of the ray of four or five oblique pairs of spines standing one behind the other; but on the other part no more than three pairs are present. The spines of the pair which stands on the furrow margin are slightly larger than the rest, cylindrical, robust at the base, tapering, and more or less pointed. In the succeeding pairs the spines are less tapering and less pointed, and the outer pairs are considerably smaller than the others; on the outer half of the ray being scarcely distinguishable from the granules on the adjacent intermediate plates. The pair next the furrow pair are often so very oblique in their

posture that at first sight the foremost spine of this pair appears as if it stood alone, the companion spine seeming at the same time to disturb the regularity of the succeeding pair.

The mouth-plates are narrow and united, forming a sharp-ridged keel along the median line, which is prolonged exteriorly into a vitreous spine-like prolongation. Their armature consists of three or four very small spines on the free margin of each plate, attached at a low level, and almost hidden by the overhanging prominence of the mouth-plates anteriorly. The last adambulacral plate merged in the mouth-plate bears larger spines than any of the others and differently shaped, there being three greatly thickened spines, and sometimes a fourth much smaller at the outer end of the series, standing in line close to the elevated keel of the mouth-plate; and a smaller one on each side of the innermost of these large spines forming a line of three on the furrow margin of the plate.

The actinal interradial areas are extensive, and reach very nearly, if not quite, to the extremity of the ray. They are occupied by numerous small and regularly disposed plates, bearing pseudo-paxilliform groups of granules, which become more spiniform and pointed on the inner part of the interradial area, whilst those near the margin and along the ray are low, subprismatic, and roundly truncate. The form of the groups on the inner part of the area is circular, and there are nine or ten spinelets with one central. The innermost paxilla, which occupies the angle of the area next the mouth-plates, has a central pedicellarian apparatus formed of three or four delicate, straight, tapering, pointed spines, rather wide apart at their bases, but meeting in a point, giving a pointed conical form to the pseudo-pedicellaria. Similar but smaller pedicellariæ may be present on five or six of the paxillæ adjacent to the adambulacral plates on the inner part of the area. The groups of granules along the ray are quadrate in form and have no resemblance to paxillæ. The whole plate and tabulum whereon the granules or spines are borne is sunken below the general actinal membrane, the groups of spines and granules alone marking the separate plates; the groups, however, are very distinctly defined, and are arranged in regular lines which proceed from the adambulacral plates to the infero-marginal plates, about ten being present in the lines adjacent to the median interradial line, whilst not more than three or perhaps four are present midway on the ray. Within the disk the adambulacral plates and their armature stand up as a prominent margin on each side of the furrow, and the inner part of the interradial area has in consequence more or less of an impressed character in the neighbourhood of the mouth-plates.

The anal aperture is subcentral and distinct.

The madreporiform body is small and slightly convex. It lies midway between the centre of the disk and the marginal plates, and is bounded on its adcentral side by a large crescentiform plate larger than any of the others on the abactinal area. The striations are fine and comparatively straight from the point of flexure, which is usually angular.

The ambulacral tube-feet have a fleshy sucker disk.

The terminal plate is very small and rounded outwardly.

Young Phase.—A small example from Christmas Harbour, Kerguelen, measuring R = 20 mm., $r = 7{\cdot}5$ mm., presents all the characters of the adult in a remarkable degree. The same low truncate uniform granules, forming the same level surface, both on the actinal and abactinal areas. There is not the slightest hesitation in saying that this example is the young of the species under notice. Its difference from the young of *Gnathaster meridionalis* of the same size is very marked and striking. There are nineteen supero-marginal plates counting from the median interradial line to the extremity. There are not more than four to seven granules in the paxillæ. The armature of the adambulacral plates is of the same character as in the adult. The vitreous spine-like prolongation of the united mouth-plates is well developed. A single pseudo-pedicellaria, conical and pointed, is present on the innermost plate in the interradial area. The odd marginal plate is small in the superior series, but that in the inferior series is relatively larger than in the adult, here re-entering the margin.

There is also a young example dredged near Marion Island, in which the rays are slightly narrower at the base, and though equally long are rather less attenuate outwardly, and the abactinal surface is somewhat less full and baggy. In these slight differences this young form resembles the adult specimens from the neighbourhood of Heard Island more closely than it does those from Kerguelen. This example is figured on Plate XIX.

Variations.—The principal variation that I have noted is in some large examples from Christmas Harbour, Kerguelen, in which the breadth of the ray at the base is greater, and gives a more triangular form to the ray. The flexible and almost baggy character of the abactinal surface is also more noticeable, from which I infer, as well as from a less collapsed example, that the form was tolerably thick and puffy over the disk when alive. The actinal area is decidedly convex; and when the whole starfish is viewed in profile, the narrow double band of marginal plates appears as a slightly nipped-together ridge midway between the abactinal and actinal convexities. It is interesting to note that in one of these examples the primary interradial plates are distinctly observable on the disk. They are small, oval, slightly convex plates, situated at about the same distance from the centre as the large crescentiform plate on the adcentral side of the madreporiform body, but are, however, of much smaller size. In one of these examples I notice a tendency to lateral compression and truncation at the tip of the innermost furrow spines in the adambulacral armature; but not in others: the circumstance is therefore only noted as a point affected by variation.

Colour in alcohol, a bleached dirty ashy or greyish white.

Localities.—Station 145. Off Marion Island. December 26, 1873. Depth 50 fathoms.

Station 149H. Off Cumberland Bay, Kerguelen Island. January 29, 1874. Depth 127 fathoms. Bottom deposit a greenish volcanic mud.

Station 150. Between Kerguelen Island and Heard Island. February 2, 1874. Lat.

52° 4′ 0″ S., long. 71° 22′ 0″ E. Depth 150 fathoms. Coarse gravel. Bottom temperature 35°·2 Fahr.; surface temperature 37°·5 Fahr.

Station 151. Off Heard Island. February 7, 1874. Lat. 52° 59′ 30″ S., long. 73° 33′ 30″ E. Depth 75 fathoms. Volcanic mud. Surface temperature 36°·2 Fahr.

Remarks.—This species is readily recognised by the length of the rays, by their narrow and tapering form, by the flexibility of the abactinal surface, and by the uniform low granulation, which in no case approaches the character of spines.

3. *Gnathaster pilulatus*, n. sp. (Pl. LVII. figs. 5–7).

Rays five. R = 42 mm.; r = 21–23 mm. R = 2 r approximately. Breadth of a ray at the base, 24 mm.

General form depressed, slightly inflated over the radial areas; marginal contour stellato-pentagonal. Rays short and triangular in form, wide at the base, tapering continuously to the extremity, with straight sides. Interbrachial arcs very wide, distinctly angular at the summit.

The whole abactinal paxillar area is covered with comparatively large, short-stalked, capitate, well-spaced paxillæ, the crown of which consists of a dozen or more low, truncate, close-fitting, prismatic granules, surrounded by a number of small papilliform spinelets, the whole forming a compact, smooth-surfaced, hemispherical knob, which has the appearance to the naked eye of a well-defined tubercle. The paxillæ are widely spaced, and the papulæ, which are large, have the appearance of emerging from the angles of a hexagonal plate. The arrangement of the paxillæ is in regular oblique transverse lines, and the paxillæ diminish gradually in size as they recede from the median line of the ray and approach the margin. In a large specimen, which has the radial inflation fairly well developed, there is a distinct depression or channel traversing the median interradial line.

The supero-marginal plates are small and quadrangular, distinctly broader than long, the sutures between adjacent plates being broad and well-defined. The supero-marginal plates are nineteen in number from the median interradial line to the extremity; and there is also an odd cuneiform plate in the median interradial line. The surface of the plates is slightly convex, and covered with low, uniformly truncate, subprismatic granules.

The infero-marginal plates correspond in number and also more or less in size to the superior series, but their armature is quite different, and causes this series of plates to appear much more prominent than the superior series, leading at first sight to the supposition that they (the infero-marginal plates) alone form the outer margin. They are covered with small, robust, conical-pointed, papilliform spinelets, their disposition giving a bristling or tufted appearance to the plates, in strong contrast to the low and uniformly

truncate granules of the supero-marginal plates. There is also an odd plate in the median interradial line, generally narrower than the others, but sometimes so nearly similar that it is hard to distinguish.

The adambulacral plates are short but broad, and their armature consists of four or five pairs of spinelets standing one behind the other, the outermost pair being much smaller than the rest, which are nearly equal. The inner pair of spines on the furrow margin are flattened and truncate at the tip, the flattening being at right angles to the furrow; sometimes the second pair are in like manner slightly flattened, but usually the second and third pair are cylindrical and truncate or obtusely rounded; the small outermost pair are more conically pointed. Occasionally there is some obliquity in the posture of the second and third pair, but this is by no means the rule.

The mouth-plates are rather small and narrow, each pair intimately united and forming a prominent keel along the median line, which is prolonged posteriorly as a short sharply-pointed vitreous spine. Their armature consists of four or five small spines on the anterior free margin of each plate, often chisel-formed in the adult; and five or six short cylindrical upright spines, which form a line on each side of the vitreous prolongation, the lines converging as they proceed outward, and the spinelets diminishing gradually in size.

The actinal interradial areas are extensive and covered with small subrhomboid pavement-like plates, regularly arranged, which diminish in size as they recede from the inner part of the area, and extend very nearly to the tip of the ray. The plates bear a paxilliform group of small conical-pointed spinelets, often subfusiform or narrower at the base than at the outer third. There may be from five to a dozen spinelets in a tuft, radiating apart slightly, and with three or four central spinelets a little longer than the rest, the separate tuft-like groups being fairly well-defined. The larger spines are nearly, but not quite, as large as those in the armature of the adambulacral plates.

The anal aperture is obscured by paxillæ, but there is no reason to doubt its presence.

The madreporiform body is small, subcircular, and slightly convex, situated nearer the centre of the disk than midway between that point and the margin. Its surface is marked with fine striations, which are considerably convoluted. The paxilla standing on its adcentral side is rather larger than the others in this neighbourhood.

The ambulacral tube-feet have a well-developed sucker-disk.

Young Phase.—In a smaller specimen than the above, measuring R = 27 mm., $r = 14{\cdot}5$ mm., there are seventeen supero-marginal plates between the odd median interradial plate and the terminal, and the whole character of the abactinal surface is precisely similar to that already described above. The singular puffball-like appearance of the paxillæ is if anything even more pronounced. The armature of the infero-marginal plates is, however, scarcely so spiniform as in the adult, this character being only developed on the actinal part of the plate,—the covering of the upper part of the plate, which enters into the lateral wall of the ray, being truncate, prismatic granules, similar to those on the supero-

marginal plates. The spinulation of the actinal intermediate plates is well-developed and delicate, the delicacy emphasising the spiniform character. The spines forming the armature of the adambulacral plates are also more delicate and relatively longer than in the adult.

Malformation of ray.—The smaller specimen above mentioned is interesting from the fact that one of the rays is bifurcate, forming two subequal branches, each having about ten supero-marginal plates on a side. The two branches are formed with great regularity, and there is no imperfection to lead to the suggestion that one has better claim than the other to be ranked as the true tip of the radius. Both have a terminal plate, and the ambulacral furrow passes along each branch regularly and equally.

Colour in alcohol, a bleached greyish white.

Locality.—Station 313. Off Cape Virgins, eastern coast of South America, near the Atlantic entrance to the Strait of Magellan. January 20, 1876. Lat. 52° 20′ 0″ S., long. 67° 39′ 0″ W. Depth 55 fathoms. Sand. Bottom temperature 47°·8 Fahr.; surface temperature 48°·2 Fahr.

Remarks.—Perhaps the nearest ally of this species is *Gnathaster meridionalis*. The present form may, however, be at once distinguished by the more depressed form of the body, by the less produced rays, which are broader at the base and distinctly triangular, by the peculiar capitate tubercle-like paxillæ, and by the character of the spinulation of the actinal area generally.

Genus *Nymphaster*, Sladen.

Nymphaster, Sladen in Narr. Chall. Exp., 1885, vol. i. p. 612.

Disk large and flat. Rays elongate, slender, tapering, and almost square in section.

Marginal plates forming a broad border to the disk, and either united along the median abactinal line of the ray throughout, or separated only by a single series of medio-radial plates. The marginal plates of both series are granulated and bear no spines.

Abactinal area of the disk covered with large and regularly arranged plates; those in the radial areas well separated, usually hexagonal, more or less tabulate and paxilliform, and frequently bearing an excavate or entrenched pedicellaria.

Actinal interradial areas large, confined to the disk. Actinal intermediate plates well defined, covered with uniform granules and occasionally bearing pedicellariæ.

Armature of the adambulacral plates arranged in longitudinal series.

Madreporiform body exposed and situated within one third of the distance from the centre to the margin.

Large entrenched pedicellariæ are frequently present on the marginal plates in some species.

Remarks.—The group of species which I have classed in this genus form two very distinct sections, one of which may perhaps ultimately be considered worthy of being recognised as a subgenus, if it be not actually accorded generic rank. From the scantiness of the material now available, I have not, however, felt justified in taking this step at present, but merely indicate what seems to me may be the possible future requirement of the case when a more extensive series of specimens can be studied.

Synopsis of the Species included in the Genus Nymphaster *herein described.*

A. Supero-marginal plates separated throughout the ray by a median abactinal series of plates. Plates of the abactinal radial areas distinctly paxilliform. Entrenched pedicellariæ present.
  a. Radial paxillæ with a large number of central granules. Rays comparatively long . . . . . *symbolicus.*
  b. Radial paxillæ with only two central granules. Rays comparatively short . *bipunctus.*

B. Supero-marginal plates united in the median abactinal line throughout the ray. Plates of the abactinal radial areas very slightly tabulate. No entrenched pedicellariæ present.
  a. Adambulacral armature with a secondary series of spinelets on the actinal surface of the plate . . . . . *protentus.*
  b. Adambulacral armature with no secondary series of spinelets; granules only on the actinal surface of the plate.
    a. Radial paxillæ hexagonal; with pedicellariæ . . . . . *basilicus.*
    b. Radial paxillæ circular; bearing no pedicellariæ . . . . . *albidus.*

So far as I can judge from the information published, I am inclined to think that the following forms will ultimately be associated with the species I have placed in this genus, viz. *Dorigona subspinosa*, Perrier, *Dorigona arenata*, Perrier, *Dorigona ternalis*, Perrier, *Dorigona prehensilis*, Perrier, and *Pentagonaster* (*Dorigona*) *moebii*, Studer. Probably *Pentagonaster alexandri*, Perrier, may also be included in the same category; and perhaps the form described under the name of *Astrogonium fallax*, Perrier, as well. *Pentagonaster elongatus*, Perrier, is another doubtful form, but from the description given appears to me to be more nearly related to one of the species I have placed in the genus *Paragonaster*, in which I venture to think it will ultimately be classed.

Chorology of the Genus Nymphaster.

a. Geographical distribution:—

Atlantic: Three (or probably nine) species between the parallels of 40° N. and 20° S.

Nymphaster albidus, off the Cape Verde Islands. *Nymphaster protentus*, south-west of the Canary Islands. *Nymphaster basilicus*, off the west coast of Brazil.

The five or six additional species dredged by the "Blake," "Travailleur," and "Talisman" Expeditions, which were mentioned above as probably belonging to this genus, are all from the North-Atlantic area.

Pacific: One species between the parallels of 10° N. and 10° S.
Nymphaster bipunctus, north of Admiralty Island.

Eastern Archipelago: One species between the parallels of 20° N. and 20° S.
Nymphaster symbolicus, off the Philippine Islands, and in the Arafura Sea. *Nymphaster symbolicus*, var. *breviradiata*, in the Banda Sea.

β. *Bathymetrical range:* 28 to 1525 fathoms.

Two species, viz., *Nymphaster bipunctus* and *Nymphaster symbolicus*, are found in the Littoral zone; and two species, viz., *Nymphaster basilicus* and *Nymphaster protentus*, are confined to the Abyssal zone.

Greatest range of one species: *Nymphaster symbolicus*, 28 to 115 fathoms.

If the additional North-Atlantic species, which I suppose to belong to this genus, be taken into consideration, the greatest range and greatest depth is attained by the species described as *Pentagonaster alexandri*, Perrier, which, according to Perrier, extends from 84 to 1930 fathoms. (I have already expressed my doubt as to the original generic reference of this form, under the head of the chorology of the genus *Pentagonaster*.) The form described as *Dorigona arenata*, Perrier, extends from 164 to 893 fathoms.

γ. *Nature of the Sea-bottom:* Each of the species dredged by the Challenger was found inhabiting ground of a different nature. The two deep-water forms, *Nymphaster basilicus* and *Nymphaster protentus*, were on Red mud and Hard ground respectively. *Nymphaster bipunctus* occurred on Coral mud, and *Nymphaster symbolicus* on Green mud, the variety of the latter—*Nymphaster symbolicus* var. *breviradiata*—living on Blue mud.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Nymphaster albidus . .	Atlantic.	...	...
Nymphaster basilicus . .	Atlantic.	1200	Red mud.
Nymphaster bipunctus .	Pacific.	150	Coral mud.
Nymphaster protentus .	Atlantic.	1525	Hard ground.
Nymphaster symbolicus .	Eastern Archipelago.	28 to 115	Green mud.
Nymphaster symbolicus var. *breviradiata* . . .	Eastern Archipelago.	140	Blue mud.

1. *Nymphaster symbolicus*, n. sp. (Pl. L. figs. 1 and 2; Pl. LIII. figs. 7 and 8).

Rays five. R = 85 mm.; r = 26 mm. R > 3·25 r. The minor radius is thus in the proportion of about 30 per cent.

General form flat and thin. Disk large and pentagonal. Rays elongate, narrow, and tapering continuously to a slender extremity; width midway between the centre of the disk and the extremity, 8·25 mm.; width at the commencement of the outer fourth, 4 mm. Interbrachial arcs wide and openly rounded.

The marginal plates are broad and massive, the outer part forming a vertical lateral wall, the abactinal and lateral areas of the plate being at right angles to one another, with the junction abrupt and subangular. The intermediate paxillar area is on a level with the supero-marginal plates, and the section of the ray is almost rectangular in outline, its horizontal diameter being twice the vertical near the base of the ray, but decreasing in proportion as it proceeds outward. The supero-marginal plates are thirty-three in number from the median interradial line to the extremity. Their length is little more than their height, and their breadth is nearly twice their height. On the outer part of the ray the length is greater than the breadth, the height remaining the least dimension. The surface of the plates is covered with a uniform, small, semiglobular, miliary granulation. The granules do not touch one another, but closely cover the whole plate, and at the lateral margins form a lineal series which helps to define the sutures between adjacent plates. The median surface of the plate is faintly convex. Each of the plates, except at the end of the ray, may bear one or two long entrenched pedicellariæ on the abactinal surface, and frequently (at least in large specimens) a rather smaller one also at the angular junction of the abactinal and lateral surfaces, but which may not, however, proceed very far along the ray. These pedicellariæ have the appearance superficially of a straight cut or slit about 1·25 mm. in length, intersected midway by a very small but wider cross cut; the jaws of the pedicellariæ have somewhat the form of the letter T, with its vertical line greatly prolonged; and when retracted, fit exactly in the excavations above described. The pedicellariæ have no definite posture on the plates. The odd terminal plate is comparatively large in relation to the neighbouring marginal plates; it is elongately shield-shaped, with the angular extremity directed inward, and the outer portion of the plate rounded subcylindrically and contracting slightly and gradually towards the extremity, which is obtuse. The infero-marginal plates correspond to the superior series, the rounding towards the actinal area being rather more decided. They are covered with a precisely similar small granulation, and each usually bears one of the entrenched pedicellariæ on the actinal surface. The breadth of the infero-marginal plates diminishes rapidly after passing the base of the ray, and thence to the extremity the length becomes the largest dimension.

The armature of the adambulacral plates consists of a furrow series of ten delicate, rather elongate spinelets, flattened laterally to a uniform thickness but tapering towards

the tip in the other dimension when seen from the side. All are of uniform length except the outermost at each end of the series, or that at the adoral end only, which is shorter; they stand compactly side by side or radiate very slightly, the base line being almost straight or presenting only a very gentle curve. The adoral spinelet is rather more robust than the rest and is placed a little backward on the plate. External to the furrow series is an outer series of six spinelets, which are much more robust than the furrow series but are about equal in length to them, except the outer ones which are smaller, the median spines being the longest. These form a curved longitudinal line, often somewhat oblique in its position on the plate; and the spines are very robust at the base, having the form of four-sided rectangular prisms, which taper to a pointed extremity. External to these are one, two, or three, longitudinal series, according to the position on the ray, of short, truncate, prismatic or polygonal granules, of equal height and well-spaced; four or five granules are present in each series, and sometimes one or two additional to fill in the interspaces caused by the obliquity of any of the series.

The actinal interradial areas are extensive and almost equilaterally triangular in outline, excepting the interbrachial curve. They are paved with well-defined actinal intermediate plates, the series adjacent to the adambulacral plates being pentagonal in shape, whilst the majority of the rest are square or rectangular, though a few may be hexagonal or irregular. The series of plates next to the adambulacral plates are about twelve to eighteen in number, and diminish in size as they proceed outward; the other plates of the area are arranged in lines parallel to the last named and consequently parallel to the furrow. The median interradial line of the area is not marked by any abrupt termination of the converging series; and the plates diminish in size as they approach the margin, being smallest at the position corresponding to the termination of the interradial line there. The plates have a series of small subprismatic granules arranged round their margin and rather well spaced; and the surface of the plate bears a number of larger and more elongate granules of prismatic form and well spaced; on the larger plates from seven to twelve or even more are present, the number and size varying in proportion to the size of the plate. Adjacent plates have the appearance of being separated by a narrow channel and this feature is further emphasised by the well-defined series of marginal granules. Entrenched pedicellariæ are present on the plates adjacent to the adambulacral plates and are there usually guarded by two or more granules, larger than the rest, placed near the median part where the jaws articulate. Similar pedicellariæ may also be found on a few of the other actinal intermediate plates, but are quite occasional and of rare occurrence.

Mouth-plates elongate and narrow, with a series of twelve spinelets on the free margin in the ambulacral furrow similar in character to the adambulacral spinelets, but increasing in robustness as they proceed inward. A lineal series of nine papilliform spinelets stands on the actinal surface of the plate parallel to the median suture; the inner three or four are moderately elongate and spiniform, robust, subprismatic, pointed, and well-spaced,

whilst the outer members of the series are simply truncate papillæ or elongate granules. On the margin of the mouth-plate adjacent to the adambulacral plate is a series of six papilliform spinelets or granules similar to the last-mentioned. One or two additional spinelets usually stand on the interspace of the plate formed by the divergence of this and the median series.

The paxillæ of the abactinal area are of two forms, and present a very ornate appearance. Those which occupy the radial portions of the disk are hexagonal, tabulate, and well spaced, with a definitely-arranged spinulation; the covering of the interradial areas, on the other hand, consists of square or rhomboid plates compactly placed and covered with a small uniform miliary granulation similar to that on the supero-marginal plates. The median radial line is occupied by a longitudinal series of transversely elongate hexagonal paxillæ, which are larger than any of the others. Their transverse diameter is 2 mm., and the longitudinal measurement (corresponding to the direction of the ray) varies from 1 to 1·5 mm. The margin of the tabulum is occupied by a regularly placed series of twenty-two to twenty-five short, prismatic, sharply truncate spinelets, their truncation being in conformity with the well-defined, regular and sharply-angular hexagonal outline of the paxilla as a whole, which is so regular that these spinelets almost appear as if trimmed into form with a knife. The central portion of the tabulum is occupied by seven to eighteen semiglobular well-spaced granules, which vary in size according to number, but are of uniform size on a given tabulum. When this series of paxillæ reaches the base of the ray proper, they lose their tabulate character and appear more like simple hexagonal plates compactly placed, and the marginal series of spinelets lose their prismatic character and become rounded granules similar to those on the surface of the tabulum, and at the same time the latter increase in number. Towards the end of the ray the paxillar plates lose their hexagonal outline and become square, and finally become so small that their serial succession is interrupted by the contact of the two corresponding supero-marginal plates from each side of the ray. The radial series then rapidly aborts, and the extremity of the ray is occupied entirely by the supero-marginal plates. On each side of the median radial line of paxillæ, within the area of the disk, are three parallel longitudinal series of similar, but somewhat smaller, hexagonal tabulated paxillæ. The outermost two are confined to the area of the disk and terminate at the base of the ray; the innermost, however, is continued a little further along the ray, nearly to the middle, but the hexagonal form is altogether lost; and all the plates near the base of the ray and any which proceed along it change the special spinulation of the tabulated paxillæ for the small miliary granulation similar to that on the supero-marginal plates above noticed. The tabulated paxillæ of the three series on each side of the median row are of the same height and character as the latter, and they stand well spaced, so that the star-like prolongations uniting the bases, as well as the papulæ, are visible. The row of paxillæ next to the median series have their transverse

diameter only very slightly greater than the longitudinal; and in the outer two series the difference is still smaller, whilst the respective diameters in the outermost series are almost equal. The tabula of the three lateral series of paxillæ bear fourteen to sixteen of the marginal prismatic spinelets, and four to eight of the semiglobular granules in the enclosed area. Most of the paxillæ of the median series bear one of the large entrenched pedicellariæ similar to those above described, which extends across the major diameter of the tabulum; and here and there a paxilla of the lateral series is similarly provided.

The interradial areas are nearly equilaterally triangular in outline, the base extending along seven or eight of the supero-marginal plates in the interbrachial arc; they are covered with small subrhomboid plates compactly placed in lines parallel to the longitudinal series of the radial areas, and are beset with small, uniform, semiglobular granules similar to those on the supero-marginal plates; some of these plates are also furnished with pedicellariæ, but they are few and far between. The converging lines of plates do not form any abrupt indication of the median interradial line.

The primary embryonic plates are clearly discernible, the primary radials and basal plates being larger than the other paxillæ; a plate representing the under-basal is also to be distinguished, and this is frequently separated from the primary radial by a pair of intermediate plates; one or more series of intermediate plates intervene between the above-mentioned primary plates and the dorso-central, which is a little larger. The anal aperture lies external to this plate, opposite the postero-lateral interradium. The madreporiform body is small and slightly convex, and is placed external to the adjacent basal plate, its position on the disk being about one-fifth of the distance from the centre to the extreme margin.

Colour in alcohol, yellowish white.

Localities.—Station 204. Off Tablas Island, Philippine group. November 2, 1874. Lat. 12° 43′ 0″ N., long. 122° 9′ 0″ E. Depth 100 to 115 fathoms. Green mud. Surface temperature 84°·0 Fahr.

Station 188. In the Arafura Sea, near the entrance to Torres Straits. September 10, 1874. Lat. 9° 59′ 0″ S., long. 139° 42′ 0″ E. Depth 28 fathoms. Green mud. Surface temperature 78°·5 Fahr.

Remarks.—*Nymphaster symbolicus* is readily distinguished from *Nymphaster protentus* and its allies by the tabulate and paxilliform character of the radial abactinal plates, by the presence of a medio-radial series of plates, which separate the two opposite series of supero-marginal plates throughout the ray, and by the presence of large entrenched pedicellariæ of a remarkable form.

1*a*. *Nymphaster symbolicus*, var. *breviradiata*, nov.

A variety of *Nymphaster symbolicus* occurs at Station 192. The form is of smaller size, but the rays are comparatively a little wider and shorter. The paxillæ of the

abactinal area are larger, and bear on the central part of the tabulum more numerous granules, which are polygonal and truncate instead of semiglobular, closely crowded, and usually form three or four lines. This form is remarkable for very peculiar additions to the pedicellariæ on the plates adjacent to the adambulacral plates. These consist of two large prominent rounded granules, placed on one side of the entrenched pedicellariæ and closely apposed together, themselves appearing like a thick massive subvalvate pedicellaria.

Locality.—Station 192. In the Banda Sea, between the Ki Islands and the Banda Islands. September 26, 1874. Lat. 5° 49′ 15″ S., long. 132° 14′ 15″ E. Depth 140 fathoms. Blue mud. Surface temperature 82°·0 Fahr.

2. *Nymphaster bipunctus*, n. sp. (Pl. LII. figs 3 and 4; Pl. LIII. figs. 11 and 12).

Rays five. R = 34 mm.; r = 12 mm. R < 3 r. The minor radius is thus in the proportion of about 35 per cent.

Rays rather short in comparison with the other members of the genus, narrow, and tapering slightly towards the extremity, which has the appearance of being rapidly pointed. Width midway between the centre and the extremity, 5·75 mm. Interbrachial arcs wide and flattened, which emphasises the pentagonal form of the disk.

The marginal plates are massive and form a vertical lateral wall, the section of the ray being rectangular in outline, with the angles slightly rounded. The supero-marginal plates are fifteen in number from the median interradial line to the extremity. The innermost plates in the interbrachial arc have their height about equal to their length, whilst the breadth as seen from above is slightly greater. As they proceed along the ray, the proportion of the height diminishes and also that of the breadth, but to a less degree, the length being the greatest dimension near the extremity. The surface of the plates is covered with a small, uniform, semiglobular miliary granulation, fairly well spaced and distributed without order on the plate, except at the lateral margins, where it forms a lineal series and has a tendency to become slightly more papilliform. The median surface of the plates is slightly convex. One of the entrenched pedicellariæ similar to those described in *Nymphaster symbolicus* occurs on the abactinal area of nearly all the supero-marginal plates, except at the extremity of the ray. The odd terminal plate is elongate and shield-shaped, angular adorally, with its free extremity subcylindrical, slightly tapering and obtusely truncate. The infero-marginal plates correspond to the superior series and are covered with similar and uniform miliary granules. Not more than two or three of the infero-marginal plates in each radial span are furnished with a pedicellaria.

The armature of the adambulacral plates consists of a furrow series of eight very delicate spinelets, except near the middle of the ray, where ten are often present, and at the extremity where the number is less. The spinelets, which are very small, elongate,

subcylindrical, and slightly tapering, radiate slightly apart, and their base line forms a gentle curve; the outermost spinelet at each extremity of the series is smaller than the others, the adoral one being the smallest, often almost aborted, and has the appearance of being placed rather far back on the plate. External to the furrow series is an outer series of four or five spinelets, which are much more robust, subpapilliform, slightly compressed, and stand in an oblique line which is farthest from the furrow adorally. The second spine from the aboral extremity of the series is the longest, and the most adoral the shortest, the intermediate spines forming a graduating series. External to these spinelets is a lineal series running parallel to the furrow, of four or five short papillæ, scarcely distinguishable from the miliary granules of the actinal intermediate plates.

The actinal interradial areas are paved with comparatively large intermediate plates, which are consequently few in number; they do not vary greatly in size, and most are subrectangular or subrhomboid in shape, though a few are irregular. All have a series of small papilliform granules arranged round their margins, and a few similar papillæ widely spaced on the surface of the plate. Most of the plates in the series adjacent to the adambulacral plates bear one of the entrenched pedicellariæ, but the other intermediate plates appear to be devoid of them, excepting perhaps a solitary one rarely.

The mouth-plates are small, elongate, and narrow. They bear a series of about ten spinelets on the margin bordering the furrow, which increase in robustness as they proceed inward, the innermost being flattened into a broad knife-like appendage, with the thin edge placed in the direction of the ray. On the actinal surface of the plate a series of spinelets runs parallel to the median suture; they increase in length as they proceed inward, the outer ones being papilliform granules. Five small papilliform spinelets border the margin adjacent to the adambulacral plate, and a transverse or diagonal series of three short cylindrical spinelets proceeds from near the termination of the latter series at the furrow, across the surface of the plate, towards the longitudinal series adjacent to the median suture. One to three small papilliform granules may also be present on the enclosed area on the outer half of the plate.

The paxillæ of the abactinal area are tabulate, hexagonal, and distinctly separate in the radial areas, whilst those of the small triangular interradial areas are square or subrhomboid and closely placed. The median radial line is occupied by a regular longitudinal series of hexagonal paxillæ, slightly larger than the rest, and with their transverse diameter a little greater than the longitudinal. On reaching the base of the ray these paxillæ lose their hexagonal form, become rectangular, and, gradually diminishing in size, do not extend beyond the middle of the ray, the supero-marginal plates of the two opposite sides of the ray uniting in the median abactinal line along the outer half of the ray. There are three parallel longitudinal series of similar paxillæ on each side of the median row. The series next to the median one have the paxillæ only very slightly elongate transversely, whilst in the outer two rows they are subcircular. None of

these outer series of paxillæ extends beyond the base of the ray. The margin of the tabulum is surrounded by ten to fourteen short, truncate, papilliform granules, and in the centre are usually two small semiglobular granules, though one only frequently occurs in the outer rows; occasionally four are present. Very few of the paxillæ on the abactinal area are furnished with pedicellariæ.

The abactinal interradial areas are very small and triangular in outline; the plates (paxillæ), which are square or subrhomboid, are closely placed and have no papulæ between them. They form series parallel to the radial series above described, but there is no abrupt indication of the median interradial line by the converging series, and not more than five or six plates are present in the longest row. These plates have a marginal series of papilliform granules and one in the centre.

The primary embryonic plates are discernible. The basals and dorso-central are larger than the other plates, and the under-basals are larger than the radials. The under-basals appear normally to be in contact with the dorso-central plate, but two or three irregular plates are present. The madreporiform body is subcircular, with numerous minute striæ, and lies external to the adjacent basal plate, which covers a rather larger area.

Colour in alcohol, a yellowish white.

Locality.—Station 219. North of Admiralty Island. March 10, 1875. Lat. 1° 54′ 0″ S., long. 146° 39′ 40″ E. Depth 150 fathoms. Coral mud. Surface temperature 84°·0 Fahr.

Remarks.—It is possible that this form may turn out ultimately to be the young of *Nymphaster symbolicus*, when a more extended range of specimens can be studied. So far, however, as judgment can be drawn from a single specimen, the characters appear to be so well marked that I prefer to place the form for the present as an independent species. The difference of the abactinal paxillæ from those of *Nymphaster symbolicus* is very marked, the armature of the adambulacral plates also, but in a less degree; furthermore, the larger size and smaller number of the actinal intermediate plates, as well as the shorter and comparatively broader rays, all seem to warrant its recognition as a distinct species, notwithstanding the fact that the characters referred to are all largely implicated in growth changes.

3. *Nymphaster protentus*, n. sp. (Pl. L. figs. 3 and 4; Pl. LIII. figs. 9 and 10).

Rays five. $R = 71$ mm.; $r = 18$ mm. $R < 4\,r$. The minor radius is thus in the proportion of about 25 per cent.

Rays elongate, tapering continuously from a fairly robust base to a slender-pointed extremity, the outer half being very narrow and attenuate. Width midway between the centre of the disk and the extremity, 5·5 mm.; width at the commencement of the outer fourth, 3 mm. Interbrachial arcs wide and well rounded.

The marginal plates are broad and massive; and the supero-marginal plates occupy the whole of the abactinal area of the ray, those of the opposite sides meeting in the median line. The abactinal or paxillar area of the disk is consequently a well-defined pentagon, which is further emphasised by a slight convexity in the central area, and a faint depression along the inner margin of the supero-marginal plates. The lateral and abactinal areas of the plates are at right angles to one another, with the junction subangular; the lateral wall being vertical, the section of the ray is rectangular in outline. The supero-marginal plates are about thirty in number (29 to 31) from the median interradial line to the extremity. In the interbrachial arc the height is a little greater than the length, but as they proceed along the ray the proportion of the height decreases, and along the outer half the length is the greater dimension. In the innermost plate adjacent to the median interradial line, the breadth is to the length in the ratio of 3 : 2, and the proportion increases up to the fifth plate, which is at the base of the ray, and is the first that unites with its corresponding plate from the opposite side of the ray in the median abactinal line. From this plate outward, the proportion of breadth gradually decreases, until near the extremity of the ray the length is slightly greater than the breadth. There is some slight irregularity in the length of the plates along the ray here and there, in consequence of which the plates of the two sides do not always correspond, nor the lateral sutures fall in one and the same line. The surface of the plates is covered with a uniform, minute, semi-globular, miliary granulation, rather widely spaced and without order upon the plate except at the margins where the series is lineal and regular. There are no spines and no pedicellariæ of any kind upon the marginal plates. The odd terminal plate is very small and subcordiform, rounded and thickened in front and angular adorally; its breadth is in conformity with the general taper of the ray, to the extremity of which it forms the obtuse termination.

The infero-marginal plates are not always regularly correspondent to the superior series, though they would appear normally to be so. The length is greater than the breadth, excepting in two or three of the innermost plates; the innermost three are also the broadest, and this is their greatest dimension; from the fourth plate outward the infero-marginal plates are contiguous to the adambulacral plates, and their length is greater than their breadth, the proportion increasing as they proceed along the ray. The junction between the lateral and actinal areas of the plate is more rounded than in the superior series. The infero-marginal plates are covered with a uniform miliary granulation rather larger than that on the supero-marginal plates, the granules having a tendency to become slightly papilliform; all are distinctly spaced and the marginal series are well defined. No spines or pedicellariæ are present.

The armature of the adambulacral plates consists of a furrow series of about seven rather short, but robust, equal spinelets, tapering to an obtuse extremity and transversely compressed; about the middle of the ray there may be nine or ten. Their base line on the

inner part of the ray is not greatly angulated, but near the base of the ray and outwards the margin of the adambulacral plate presents a sharply defined angular prominence into the furrow, and the spinelets which are arranged on this margin have the appearance of being divided into two divergent sets—one on the adoral facet and the other on the aboral, the spines on each being directed at right angles to the base line and nearly parallel to one another on the same facet. Frequently a single spinelet stands at the apex of the angle from which the two sets above mentioned appear to diverge. Near the middle of the ray the adoral facet is the shorter and does not bear more than three or four spinelets; and towards the extremities of each series the spinelets are usually compressed in the direction of the margin of the plate to which they are attached, whilst the median spinelets remain compressed transversely as previously remarked. External to the furrow series is a series of short papilliform spinelets, slightly compressed and tapering to an obtuse extremity. Near the mouth-plates, where the adambulacral plates are short, there are only two of these outer spinelets, but the number gradually increases as the plates become longer, until six are present near the middle of the ray. The line is slightly angulated in correspondence to that of the furrow series, but to a less degree. The most adoral spinelet (papilla) of the series is the smallest, and the rest are fairly subequal, the median one at the apex being, however, sometimes faintly larger. These spinelets decrease in size as they proceed outward from the mouth, until they become little more than granules, before attaining the middle of the ray. The outer part of the plate is occupied by two series of small conical granules scarcely larger than those on the actinal intermediate plates, about five in each, and there are often a few additional spinelets corresponding to the increased area caused when angularity occurs in the lines of spines.

The actinal interradial areas are comparatively small, whilst the intermediate plates are large and few in number. Those adjacent to the adambulacral plates are normally rectangular, but some irregularity in shape frequently occurs throughout the area. All the plates are well defined and are covered with small subconical granules, which are well spaced and decrease a little in size as they approach the margin of the plate, where a marginal series is more or less regularly formed, the small granules of which it is composed having a tendency to become conical and pointed. There are no pedicellariæ on the actinal intermediate plates.

The mouth-plates, which are small and inconspicuous, have an armature of eight or nine spinelets on the furrow margin similar to those on the adambulacral plates, and behind these a parallel series of three or four spinelets, pointed and more robust; the outer part of each plate is occupied by four or five short, conical, pointed papillæ, more or less irregular in disposition, but three of which usually form a line parallel to the median suture-line of the plates. Occasionally one or two additional spinelets of larger size are present on the median part of the plate.

The plates of the abactinal area are all normally uniform in shape and character; they

are hexagonal and diminish in size as they approach the margin, and do not assume the form of paxillæ. A longitudinal series of plates rather larger than the rest proceeds along the median radial line, and the other plates are arranged in longitudinal series parallel to this. The primary embryonic plates are discernible. All the plates are covered with uniform, small, semiglobular, miliary granules distinctly spaced and without any order of arrangement excepting a definite marginal series. The granules on the centre of the larger plates are the faintest trace larger than the rest. All the plates have the appearance of being definitely spaced in consequence of the position of the marginal granules, though the distance of separation is very narrow. When the granules are removed the plates may be seen to be in contact with six adjacent plates by small extensions of the respective plates, and that single papulæ occupy the interspaces. A number of the plates bear small pedicellariæ, the jaws of which resemble those of the entrenched pedicellariæ, but are smaller; and they are placed over a simple perforation in the plate, without the slit-like trench for the disposal of the jaws.

The anal aperture lies external to the dorso-central plate.

The madreporiform body is rather large, prominent, button-like, and lies external to a pair of plates which appear to be the representatives of the basal plate. Its position on the disk is about one-third of the distance between the centre and the margin. The striations are fine and numerous. A cycle of rather large plates surrounds the dorso-central plate and intervenes between this and the under-basals (?).

Colour in alcohol, a very light brownish white.

Locality.—Station 3. South-West of the Canary Islands. February 18, 1873. Lat. 25° 45′ 0″ N., long. 20° 14′ 0″ W. Depth 1525 fathoms. Hard ground. Bottom temperature 37°·0 Fahr.; surface temperature 63°·0 Fahr.

Remarks.—A comparative review of the characters of *Nymphaster protentus* in relation to those of its allies will be found embodied in the descriptions of *Nymphaster albidus* and *Nymphaster basilicus*.

This species is readily distinguished from *Nymphaster symbolicus* and *Nymphaster bipunctus* by the character of the abactinal radial plates, by the junction of the superomarginal plates in the median abactinal line throughout the ray, and by the absence of entrenched pedicellariæ on the marginal plates.

4. *Nymphaster albidus*, n. sp. (Pl. LI. figs. 1 and 2; Pl. LIII. figs. 5 and 6).

A single example of a *Nymphaster* was dredged near the Cape Verde Islands, which has a minor radius of 13 mm., and the longest remaining portion of the major radius measuring 48 mm. I am in much doubt as to whether it is an immature stage of *Nymphaster protentus* or a distinct species. Owing to our total ignorance of the actual growth phases of *Nymphaster protentus*, the former view would be purely conjectural; and as the differ-

ences from that type presented by the example under notice are considerable, and scarcely fall within the range of what might be expected in the young phases of the species referred to, I have considered it the safest course to regard the form in question as a distinct species, at least until other specimens are obtained which may throw light upon the relationship of these nearly allied forms. The following characters may be noticed in comparison with those of *Nymphaster protentus* as given in the foregoing description.

In the armature of the adambulacral plates, the furrow series accord in their manner of disposition with those of *Nymphaster protentus*, but are not compressed; the number on the plate is also rather less, five or six being present on those near the mouth, and eight or nine about the middle of the ray. The adambulacral plates are comparatively broader, especially near the mouth, and there is no external series of spinelets as in *Nymphaster protentus*, their place being occupied by a row of granules similar in all respects to those which stand on the outer part of the plate. There are thus three longitudinal series of equal-sized granules behind the furrow series on the inner half of the ray (reduced to two near the middle), and there are usually five or six granules in each series. In harmony with these modifications in the appendages of the adambulacral plates, the armature of the mouth-plates is less echinulate than in the larger form *Nymphaster protentus*.

Within the abactinal paxillar area, the plates of the median radial line, and the two parallel series on each side are oval or subcircular in outline instead of being hexagonal; this shape at least being clearly defined by the marginal series of granules; the latter are semiglobular and surround a central group of five or six granules on the middle of the tabulum. This small number forms a marked contrast to the closely crowded granulation of the plates in *Nymphaster protentus;* and, what is still more striking, the granules themselves are comparatively larger in *Nymphaster albidus*, which is the smaller form.

The supero-marginal plates in the inner part of the interbrachial arc are very tumid on the lateral wall of the disk, and extend beyond, and appear to overhang, the infero-marginal series. When the lateral wall of the disk is placed in the direct line of view, the line of suture which separates the superior and inferior series of marginal plates is seen to take a bold and well-defined curve, with the convexity downwards, in the inner part of the arc, —the supero-marginal plates thus encroaching on the inferior series, the height of the former being considerably greater. This formation does not, however, affect the general thickness of the marginal wall taken as a whole.

On the actinal area of the disk there is a considerable amount of inflation and the surface is convex; there is also a slight depression of triangular form on the outer part of the actinal interradial area in the neighbourhood of the interradial line and bounded by the inner margin of the infero-marginal plates. Both the superior and the inferior series of marginal plates along the ray have their greatest dimension in the length, whilst in *Nymphaster protentus* above described the supero-marginal plates are broader than long until

near the extremity of the ray. In *Nymphaster albidus* the rays appear to be comparatively narrower at the base and consequently more slender, and they taper less gradually.

Locality.—Off the Cape Verde Islands. (Exact position and conditions not recorded.)

5. *Nymphaster basilicus*, n. sp. (Pl. LVII. figs. 8 and 9).

I have felt obliged to place a single example of *Nymphaster* dredged at Station 125 as a distinct species. The size of the specimen denotes a large robust form, but unfortunately in the present case each of the rays had suffered mutilation during life, and four of them are now represented only by dwarfed and imperfectly grown reproductions; it is consequently impossible to give accurately the measurement of the major radius or the number of the supero-marginal plates. The minor radius measures 28·5 mm.; and judging from a ray which has been mutilated, but not entirely removed, as in the case of the other four, the major radius was about 91 mm. or more, for the extremity even in this ray is not absolutely perfect.

The plates of the abactinal paxillar area are regularly hexagonal, those of the radial regions are nearly uniform in size in the respective series, and diminish slightly as they proceed outward. All are definitely and uniformly spaced slightly apart, the isolated and regularly placed papulæ being visible. The plates of the interradial regions, on the other hand, are smaller and closely crowded; and from the fact that they diminish in size as they approach the margin of the disk, the plates, which are arranged in longitudinal series parallel to the median radial series, also appear to fall into series obliquely transverse, passing from the median line to the margin of the disk, towards which they converge slightly in consequence of the decrease of size above mentioned. Nearly all the larger plates carry one of the small pedicellariæ in a pit, always placed near the margin of the plate, and rarely two are present. The dorso-central plate and its surrounding circlet of plates, which intervene between it and the basals and under-basals, are large and distinct. The anal aperture lies external to the dorso-central plate, and the madreporiform body is independent of, and lies external to, its adjacent basal plate, which is rather smaller. There is a little depression in the triangular interradial regions which gives a slight appearance of convexity to the radial regions.

In the armature of the adambulacral plates, the furrow series of spinelets accords with those already described in *Nymphaster protentus*, but there is no external series of spinelets as in that form, the whole of the outer portion of the plate, which is large, being covered with numerous small semiglobular granules, uniform in all respects with those on the actinal intermediate plates. The granules usually fall into three or four subregular longitudinal lines, but some of these may be angulated, and there is often considerable

irregularity. On a moderate-sized plate there are about five granules in a line. Several of the adambulacral plates on each side of the furrow have a small pedicellaria with three or four valves, which are squamiform and very little longer than the height of the granules. The pedicellaria is usually situated in the first line of granules behind the furrow series of spinelets, and lies between the adoral margin of the plate and the middle of the line.

The actinal intermediate plates are square or subrhomboid, and are covered with rather large, uniform, semiglobular granules, definitely spaced; a few of the plates in each area bear a small valvate pedicellaria, the jaws of which are but slightly higher than the granules, but are twice as broad. They are placed over a puncture in the plate, and are surrounded by a small circular scrobicule, devoid of granules.

The armature of the mouth-plates is granuliform on the outer part of the mouth, and here scarcely distinguishable from those on the actinal intermediate plates, but the granules increase in size as they approach the inner end of the plates, and as they assume the true spinelet form they also become subprismatic in shape.

Locality.—Station 125. Off the western coast of Brazil, near the mouth of the Rio San Francisco. September 12, 1873. Lat. 10° 46′ 0″ S., long. 36° 2′ 0″ W. Depth 1200 fathoms. Red mud. Surface temperature 77°·0 Fahr.

Remarks.—Although I have felt some doubt as to the propriety of regarding this form as a distinct species, I do not see my way to rank it merely as a variety of *Nymphaster protentus*. The much shorter ray, the smaller number of granules on the abactinal plates, the absence of any external spinelets in the armature of the adambulacral plates, and the substitution in their place of numerous granules, all seem contradictory to such a view. Indeed the characters enumerated are quite at variance with what one would expect to find in a merely larger development of the form described as *Nymphaster protentus*, especially when regard is had to the relative characters of that species and *Nymphaster albidus* described in the preceding pages.

Careful study of the three forms, *Nymphaster protentus* from Station 3, *Nymphaster albidus* from the Cape Verde Islands, and *Nymphaster basilicus* from Station 125, lead to the almost inevitable conclusion that if the small *Nymphaster albidus* should ultimately prove to be the young of *Nymphaster protentus*, the specimen under notice (*Nymphaster basilicus*) cannot be a merely larger-grown example of that form, as the characters it presents do not accord with the scheme of growth stages indicated by the other two forms; and *vice versâ*, if this large individual (*Nymphaster basilicus*) be considered as the adult form of the type *Nymphaster protentus*, the small specimen *Nymphaster albidus*, from the Cape Verde Islands, must be considered as an independent species.

Under these circumstances the course that has seemed to me to be the least open to objection has been that of ranking the three forms, provisionally at least, as separate species.

Nymphaster basilicus is probably nearly related to the form described by Perrier under the name of *Pentagonaster ternalis*[1] (which has subsequently been ranked by him as a *Dorigona*[2]). So far as I can judge from the brief and general description, but excellent figure, of *Pentagonaster ternalis*, the form under notice appears to me to be specifically distinct.

Genus *Paragonaster*, Sladen.

Paragonaster, Sladen in Narr. Chall. Exp. 1885, vol. i. p. 617.

Disk small and pentagonal. Rays elongate, narrow, slender, and though tapering, nearly uniform in breadth throughout.

Supero-marginal plates separated from those of the opposite side of the ray by a single lineal series of regular quadrate plates. Marginal plates of both series and the medio-radial series of intermediate abactinal plates all uniformly granulated. The infero-marginal plates, at least on the inner part of the ray, may bear a transverse series of small, prominent, and more or less definite, spinelets.

Abactinal area of the disk, which may be more or less inflated in the radial regions, covered with uniform, hexagonal, tabulated plates, more or less paxilliform.

Adambulacral plates broad, and bearing on their margins at right angles to the furrow a number of small uniform spinelets, directed towards the adjacent plate, which form a continuous series with the spinelets on the furrow margin of the plate, the last mentioned spinelets being larger, flattened transversely, arranged in a semicircle, and radiating apart. Within this marginally disposed armature, whose base-line forms a parabolic curve, a transverse line of three or four isolated conical spinelets or papillæ may traverse the breadth of the plate, or in a form where the plates are less broad, the spinelets or granules may be more grouped and irregular in disposition. One spinelet on the outer part of the plate may be longer and more prominent than the rest, but this character may not extend beyond the inner half of the ray.

Remarks.—The species which I have included in this genus have a decided and well-marked facies, and may be at once distinguished from *Nymphaster* by the character of the adambulacral armature, as well as by their general form.

The starfish described by Perrier[3] under the name of *Pentagonaster elongatus* appears to me from the description given to be nearly allied to this genus, and I have a strong suspicion that it will ultimately prove to be *Paragonaster*.

[1] *Bull. Mus. Comp. Zoöl.*, Harvard, 1881, vol. ix., No. 1, p. 20; *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi. p. 233, pl. x. fig. 1.

[2] *Ann. Sci. Nat.* (Zool.), 1885, t. xix., Art. No. 8, p. 39.

[3] *Ann. Sci. Nat.* (Zool.), 1885, t. xix., Art. No. 8, p. 38.

Chorology of the Genus Paragonaster.

α. *Geographical distribution:*—

Atlantic: One species between the parallels of 0° and 10° N.

Paragonaster cylindratus, near the Equator, due south of the Cape Verde Islands.

If *Pentagonaster elongatus*, Perrier, ultimately proves to be a *Paragonaster*, as I suspect, it will give two species to the Atlantic, and will extend the range of the genus northward to about the fortieth parallel, or perhaps a little further.

Eastern Archipelago: One species between the parallels of 0° and 10° S.

Paragonaster ctenipes, in the Banda Sea, between the Ki Islands and Banda Islands.

β. *Bathymetrical range:* 140 to 1850 fathoms.

As known at present, *Paragonaster cylindratus* is only found in the Littoral zone, whilst *Paragonaster ctenipes* is confined to the Abyssal zone.

γ. *Nature of the Sea-bottom:* *Paragonaster ctenipes* inhabits a ground of Blue mud; *Paragonaster cylindratus* one of Globigerina ooze.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Paragonaster ctenipes . .	Eastern Archipelago.	140	Blue mud.
Paragonaster cylindratus .	Atlantic.	1850	Globigerina ooze.

1. *Paragonaster ctenipes*, n. sp. (Pl. LI. figs. 5 and 6; Pl. LIII. figs. 1 and 2).

Rays five. R = 48 mm.; r = 12 mm. R = 4 r. Breadth of the ray midway between the centre and the extremity, 4·5 mm.

Rays elongate, slender, tapering towards the extremity, rather flat and thin, the transverse section having a vertically depressed oval outline. Interbrachial arcs wide and faintly flattened. Rays very flexible in a vertical direction.

The marginal plates are very broad, and limit the comparatively small and regularly pentagonal paxillar area of the disk. The supero-marginal plates are thirty-eight to forty in number from the median interradial line to the extremity. Those on one side of the

ray are separated from the corresponding series on the other side only by a single continuous series of small rectangular plates which occupies the median abactinal line and extends to the extremity. The breadth of the supero-marginal plates is greater than the length throughout the whole ray, all being remarkably short. In the innermost plates the breadth is greater than twice the length—approximately in the proportion of 5 : 2; the breadth increases up to the fourth plate, which is the largest and stands at the base of the ray; outward from this plate the breadth gradually diminishes until at the extremity its proportion to the length is not greater than 3 : 2, and may be less. The length diminishes very slightly and gradually as the plates proceed along the ray, being near the middle of the ray very little less than at the interradial line; the twenty-eighth and twenty-ninth plates together measure the same length as the innermost plate. The surface of the plates presents no median tumidity, and it slopes gradually from the inner end until near the margin, where the curvature becomes more rapid, the outline in section being a depressed oval. The surface of the plates is covered with a minute uniform miliary granulation, rather widely spaced and disposed without definite order. Along the margins of the plate is a regular lineal series of uniform granules, rather larger than the rest, which have the appearance of being subprismatic and truncate, whilst the others are semiglobular. The plates are separated by a narrow but distinct furrow.

The infero-marginal plates correspond exactly to the superior series, all beyond the third are contiguous with the adambulacral plates, and, excepting those in the disk proper, their breadth is much less than that of the superior series. Their surface is covered with minute papilliform granules whose posture upon the plate is somewhat oblique and directed outward, and with a decided tendency to become squamiform; they are tolerably well spaced and without definite order of arrangement, except at the margins, where a lineal series is regularly maintained and arches over the furrow between adjacent plates. On five or six plates on each side of the median interradial line there is a median series of four or five small, compressed, tapering, and sharply pointed spinelets, of equal size and at wide distances apart; still so small that they are undiscernible to the naked eye. One or rarely two of these may occasionally be traced upon a plate even beyond the middle of the ray.

The armature of the adambulacral plates is remarkable. Each plate has a prominent and more or less acute angle projecting into the furrow: on this margin are borne about seven spinelets, three on each facet and one at the apex; all are short, compressed, expanded at the tip, and roundly truncate. The central one, or occasionally two, is placed with the compression at right angles to the direction of the ray, whilst the others usually have their compression in the same plane as the line of the facet to which they are attached. These spinelets decrease a little in length as they recede from the apical one, and when expanded over the furrow radiate slightly apart; the arrangement of these spinelets *per se* might well be described as palmo-radiate, but that character as normally understood is modified considerably by the manner in which the other spinelets upon the plate are placed.

This is as follows: On the lateral margins of the plates, *i.e.*, at right angles to the furrow are a series of spinelets which have the appearance of being in direct continuation of the furrow series above described; they are not compressed, however, but papilliform, and they decrease in size as they recede from the furrow. A few similar papilliform spinelets proceed along the outer extremity and thus complete a series surrounding the whole margin of the plate. Those on the lateral margins are slightly inclined over the rather wide furrow that separates adjacent plates towards the corresponding series of spinelets on the next plate. The adambulacral plates being very broad on the inner part of the furrow there are about seventeen or eighteen spinelets on the lateral and furrow margins there; the proportion of breadth decreases as the plates proceed along the ray and the number of spinelets is consequently less, being about thirteen or fourteen near the middle of the ray. The adambulacral plates on the inner part of the ray have a single lineal series of four or five small spinelets standing on the median line of their area, parallel to the lateral margins, and consequently obliquely transverse to the furrow. Further out additional spinelets occur on the outer part of the plate, and there is a tendency to form two converging series, the point of the wedge being towards the furrow. One of the spines near the outer end of the plate is longer than the rest, very delicate, tapering, and sharply pointed. This minute spinelet is continuous throughout the series, excepting the innermost three plates and at the extreme tip.

The actinal interradial areas are very small and triangular in outline. They are occupied by a comparatively small number of rather small plates, the margins of which are beset with moderately elongate papillæ, with one or more in the centre; all the spinelets are of equal length, rather wide apart, and stand nearly vertical, which gives the plates a somewhat paxilliform character, though the armature would be more correctly described as forming a rather widely spaced group.

The mouth-plates are small and elongate, with nine or ten spinelets on the free margin; the outermost three or four of this series are compressed and truncate, the rest cylindrical, tapering, and sharply pointed, and the innermost are the longest. A lineal series of about eleven small spinelets runs parallel to the median suture, the innermost nearly as long as the marginal series, whilst the outermost are merely papilliform granules. On the margin adjacent to the adambulacral plate is a series of five or six spines, which rapidly diminish in size as they proceed outward, and do not always extend as far as the median series above mentioned. At the widest part of the plate there is an intermediate series of about four spines midway between the outer series of spines and that adjacent to the median suture, and parallel to the latter.

The well-defined pentagonal area of the abactinal paxillæ is slightly inflated, especially in the radial regions, the character being there emphasised by a slightly depressed central area, from which shallow channel-like continuations extend along the interradial lines, but die out before reaching the margin.

Outward from the primary radial plate, the median radial line is occupied by a longitudinal series of hexagonal paxillæ, eight in number up to the base of the ray, the series being then continued along the ray in the form of rectangular plates, regularly square (excepting the first), against which the supero-marginal plates on each side of the ray abut. This series of plates measures about 1·5 mm. in breadth at the base of the ray, and 1 mm. midway between the centre of the disk and the extremity of the ray. Parallel to the median radial series of disk paxillæ are other longitudinal series of similar, but slightly smaller, hexagonal paxillæ, which diminish slightly in size as they approach the margin, their inner limit being the interradial line. The moderate-sized paxillæ are regularly hexagonal, with the margin beset with about twenty very short, subprismatic, truncate, papilliform spinelets, and having about seven to ten small uniform semiglobular granules rather widely spaced on the tabulum: the number varying a little according to the size of the plate. It should be noted, however, that the plates which occupy the depressed central area and its interradial extensions are more like plates than paxillæ, whilst those of the subinflated radial areas of the disk are distinctly paxilliform. The single series of small square plates which occupies the median abactinal line of the ray are covered with small semiglobular granules precisely similar to those on the supero-marginal plates, lineal marginal series being defined, especially on the lateral margins.

The dorso-central plate is distinct and surrounded by a cycle of seven equal-sized plates; this in turn is succeeded by a series of more numerous but less regular plates, amongst which the representatives of the under-basals must be sought. Some irregularity masks the easy recognition of the latter, but where they do appear regularly placed they are separated from the primary radial by a pair of plates. The basal plates appear to be smaller and less conspicuous than the primary radials and are nearly at the same distance from the centre. The madreporiform body is small and sunken, situated external to the adjacent basal. The anal aperture is external to the dorso-central plate.

No pedicellariæ of any kind are present.

Colour in alcohol, ashy white on the marginal plates and on the depressed area of the disk; whilst the inflated portion is of a very light brown shade, as are also the actinal interradial areas.

Locality.—Station 192. In the Arafura Sea, between the Ki Islands and Banda Islands. September 26, 1874. Lat. 5° 49′ 15″ S., long. 132° 14′ 15″ E. Depth 140 fathoms. Blue mud. Surface temperature 82°·0 Fahr.

2. *Paragonaster cylindratus*, n. sp. (Pl. LI. figs. 3 and 4; Pl. LIII. figs. 3 and 4).

Rays five. R = 51 mm.; r = 12·5 mm. R > 4 r. Breadth of the ray midway between the centre and the extremity, 4·5 mm.

Rays elongate, slender, narrow at the base, slightly tapering towards the extremity,

cylindrical, slightly oval in section, apparently rigid. Interbrachial arcs wide, with a flattened curve emphasising the pentagonal character of the disk.

The marginal plates form a well-rounded lateral wall to the disk and rays. On the disk they do not extend far upon the abactinal area, being simply confined to the rounding of the lateral wall; throughout the whole length of the ray, however, the supero-marginal plates of one side are separated from those of the other only by a very narrow longitudinal series of small square plates which occupies the median radial line. The supero-marginal plates are thirty-eight in number from the interradial line to the extremity. Their apparent height as seen when the side of the ray is placed in full view is about equal to their length, except along the margin of the disk where the height is greater. Their breadth when seen from above is greater than their length throughout the ray, in the plates at the base being in the proportion of about 3 : 2, or even a little more; the relative proportions of the length diminishing towards the extremity. The surface of the plates presents no tumidity, and their curvature, when seen in section, is conformable to that of a sector of an oval cylinder. The surface of the plates is covered with a small, uniform, definitely-spaced, semiglobular, miliary granulation, disposed without any definite order upon the plate, excepting a regular lineal series of granules round the margin, which are of the same size as the rest, and whose presence marks out a narrow but well-defined channel separating the plates. The odd terminal plate is elongate and shield-shaped, the free portion being subcylindrical and slightly tapering, but obtuse at the extremity. Its posture in relation to the ray is at a slight angle to the horizontal, directed upward.

The infero-marginal plates correspond in length and height to the superior series, but in breadth they extend further upon the actinal surface of the disk than the supero-marginal plates do on the abactinal area. From the fifth plate outward they are contiguous to the adambulacral plates and their breadth is very little greater than their length, whilst on the outer part of the ray the length becomes the greater dimension. They are covered with minute papilliform granules, which at the outer end of the plate are scarcely distinguishable from the granules of the supero-marginal plates, but increase slightly in length and stand at a small angle on the plate as they approach the opposite or inner end. Along the median line of the plates in the interbrachial arc are four or five very small, flattened, tapering, sharply-pointed spinelets, appressed to the plate and scarcely noticeable by the naked eye. At the inner extremity two usually stand near together, obliquely side by side; the others are isolated and wide apart on the median line of the plate. These little spinelets decrease in size and number along the ray, and it is not easy to discover traces of them far beyond the middle of the ray.

The adambulacral plates have an angulated margin projecting into the furrow, which is rather obtuse and with a tendency to become semicircular. Their armature consists of a furrow series of five or six short, equal, cylindrical, papilliform spinelets, contracting a

little towards the bluntly pointed tip; three are usually placed on each facet of the angulated margin, and when directed over the furrow their radiation is more or less dominated by an apparent separation into two sets, to a certain extent divergent from one another. The furrow series has the appearance of being continued along the lateral margins of the adambulacral plates (*i.e.* at right angles to the furrow), in consequence of the presence of three or four short papilliform spinelets. These spinelets diminish in size as they recede from the furrow margin, and their number decreases as the breadth of the plates becomes less as they proceed along the ray. A lineal series of three or four small papilliform granules proceeds along the outer end of the plate, parallel to the furrow, and thus completes the surrounding of the outer margin. On the area of the plate are one or two small spinelets similar to the furrow series, but one is often slightly longer and more pointed, and is placed in such a manner between the first spinelets of the lateral series of each side of the plate as to appear to form with them a longitudinal series parallel to the furrow, and with the small marginal series on the outer end of the plate. On the plates close to the mouth-plates additional spinelets are present.

The actinal interradial areas are small and triangular, with the base slightly curved. They are covered with small paxilliform plates which bear short papilliform spinelets, marginally placed, with one or more central, but owing to crowding and irregularity they often appear more or less like groups and are badly defined.

The mouth-plates are elongate, suboval, and slightly convex or subtubercular on the actinal surface. They are rather closely covered with short papilliform spinelets, the number and arrangement of which it is difficult to formulate. There may, however, be distinguished (1) a series running parallel to the median suture; (2) a series on the opposite angulated margin,—part falling in the furrow, which is more or less crowded as it reaches the mouth, and part on the margin adjacent to the adambulacral plate; and (3) some intermediate spinelets usually confined to the inner and median part of the area. The spinelets are all short and vary very little in size, though they diminish slightly on the outer part of the plate: the mouth-plates consequently have a very echinulate appearance.

The abactinal paxillar area is a well-defined pentagon, with slightly curved sides; and its general surface does not exhibit any special inflation. Outward from the primary radial plate the median radial line is occupied by a longitudinal series of hexagonal paxillæ which diminish slightly in size and gradually assume a quadrate shape as they approach the base of the ray; from this point they are continued along the median line of the ray as an uninterrupted series of uniform, small, square plates, against which the supero-marginal plates on each side of the ray abut. The breadth of these plates at the base of the ray is slightly less than 1 mm. Parallel to the median radial series of disk paxillæ are other longitudinal series of similar paxillæ, each series showing a slight diminution in the size of the paxillæ as they recede from the median series. These lateral series

of paxillæ are bounded at the one extremity by the marginal plates of the disk and at the other by the median interradial line, and the paxillæ in each series diminish slightly in size as they approach the margin. In addition to their longitudinal arrangement the paxillæ appear to fall into regular obliquely transverse lines proceeding from the median interradial line to the margin of the disk. From this circumstance, together with the fact that the larger paxillæ are in the neighbourhood of the primary radial plate, and that the rest diminish as they recede therefrom, the ornamentation of the disk has a very characteristic appearance. The larger paxillæ are regularly hexagonal, with their margin beset with fifteen to eighteen very short, robust, subprismatic, truncate, papilliform granules, and with four to nine slightly larger but irregular-sized ones on the tabulum, usually definitely spaced but also more or less polygonal. On the smaller plates the number of granules is less, but they appear quite as large and robust as those on the larger paxillæ. The single series of small square plates which occupies the median abactinal line of the ray are covered with small semiglobular granules similar to those on the supero-marginal plates. The dorso-central plate is small and scarcely distinguishable from the numerous rather small plates which occupy the central area of the disk. In like manner it is not practicable to indicate definitely the representatives of the basals and under-basals. The madreporiform body is small and almost hidden by the surrounding paxillæ; it lies external to its adjacent (basal ?) plate, and its position is about midway between the centre of the disk and the margin.

No pedicellariæ of any kind are present.

Colour in alcohol, a slightly yellowish ashy grey, with a darker dirty bluish grey shade over the paxillar area.

Young Phase.—In a small specimen measuring R = 30 mm., $r = 8{\cdot}5$ mm., the basal plates are clearly distinguishable and are the largest paxillæ on the disk. Internal to the primary radial plate are a pair of plates,—a character which may also be noted, but less easily, in the larger example.

Locality.—Station 106. Near the Equator, due south of the Cape Verde Islands. August 25, 1873. Lat. 1° 47′ 0″ N., long. 24° 26′ 0″ W. Depth 1850 fathoms. Globigerina ooze. Bottom temperature 36°·6 Fahr.; surface temperature 78°·0 Fahr.

Remarks.—The specimen which forms the subject of the above description is unfortunately without any indication whatever of its locality. It was found in Sir Wyville Thomson's study after his death. The smaller specimen, which is precisely correspondent in every respect and unquestionably belongs to the same species, was dredged at Station 106.

In many respects this species differs so considerably from *Paragonaster ctenipes* that at first sight it would scarcely be thought to belong to the same genus. The character of the abactinal ornamentation has quite a different appearance; and the broad adambulacral plates of *Paragonaster ctenipes* present a feature special to that species. Care-

ful study, however, reveals the fact that both the species are formed on the same plan of structure, and I feel little hesitation in ranking them accordingly under one generic head.

Genus *Nectria*, Gray.

Nectria, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 287.
Goniodiscus (*pars*), Müller and Troschel, System der Asteriden, 1842, p. 60.

I see no reason for removing this well-marked genus from the Pentagonasteridæ; although M. Perrier[1] has taken that step in the list of species in his memoir on the Geographical Distribution of Starfishes. It is true that the form in many respects has an intermediate character between this family and the Linckiidæ, but the balance of its structural details appears to me to be unquestionably Pentagonastrid; and the further evidence borne by the young stages collected by the Challenger seems, in my opinion, to emphasise conclusively the justice of its retention in that group.

Chorology of the Genus Nectria.

a. Geographical distribution:—

Southern Ocean and South Pacific: One species (or perhaps two) between the parallels of 10° and 50° S.

Nectria ocellifera in Bass Strait (Challenger); "Mers australes" (Péron and Lesueur). *Nectria ocellata* (? specifically distinct) from Tasmania and Bass Strait. I have seen[2] an example of *Nectria* brought from the Fiji Islands, which I refer to the same species.

β. Bathymetrical range: Littoral zone to 40 fathoms.

γ. Nature of the Sea-bottom: Sand and Shells (*Nectria ocellifera*; Challenger).

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Nectria ocellifera . .	Southern and South Pacific.	30 to 40	Sand and Shells.
(*Nectria ocellata*) . .		...	.....

[1] *Nouv. Archives Mus. Hist. Nat.*, 1878, 2e Série, t. i. p. 79.

[2] I am indebted to Mr. Fred. Humble of Leeds for the opportunity of examining this specimen, which was found off the Island of Cicia, one of the windward group of Fiji Islands.

1. *Nectria ocellifera* (Lamarck), Gray (Pl. LV. figs. 1–7).

Asterias ocellifera, Lamarck, 1816, Hist. nat. anim. s. vert., t. ii. p. 553.
Nectria oculifera, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 287.
Goniodiscus ocelliferus, Müller and Troschel, 1842, System der Asteriden, p. 60.
Chætaster munitus, Möbius, 1859, Neue Seesterne des Hamburger und Kieler Museums, p. 3, Taf. i. figs. 1 and 2 (Abhandl. a. d. Gebiete Naturw. hrsg. v. d. naturwiss. Verein, Hamburg, Bd. iv. Abth. 2, 1860).
Nectria ocellifera, Gray, 1866, Synop. Spec. Starf. Brit. Mus., p. 15.

Locality.—Station 162. Off East Moncœur Island, Bass Strait. April 2, 1874. Lat. 39° 10′ 30″ S., long. 146° 37′ 0″ E. Depth 38 to 40 fathoms. Sand and shells. Surface temperature 63°·2 Fahr.

Several examples of this starfish were collected at the above station, and are chiefly interesting on account of showing different stages of growth. Only one example is large and mature; and this specimen agrees in the form of the ray and the character of the paxillæ with the description given by Perrier[1] of his *Nectria ocellata*, whilst the adambulacral armature is that of *Nectria ocellifera*. *Nectria ocellata* is the form which Gray called *Nectria ocellifera* and referred to Lamarck's species *Asterias ocellifera*; Perrier, however, considers that Gray's form is distinct from Lamarck's. The small examples, on the other hand, have the short rays of *Nectria ocellifera*, but have the adambulacral armature of *Nectria ocellata*. Under these circumstances I have refrained from referring the adult specimen to Perrier's *Nectria ocellata*, and I feel in doubt as to whether that species is really distinct from *Nectria ocellifera*, Lamarck, sp., or is only a growth-stage.

The largest of the Challenger examples has elongate, conically cylindrical, tapering rays, the major radius being about three and a half times greater than the minor radius, R = 64 mm, $r = 18$ mm. In the armature of the adambulacral plates there are two rows of elongate papilliform granules, the furrow series having two or occasionally three, and the outer row two granules. The large prominent paxillæ of the abactinal surface taper slightly from the base to the tabulum and are not hour-glass-shaped; the granules in the series that surrounds the margin of the tabulum are distinctly smaller than those on the centre of the tabulum, but they do not in any sense become modified into flattened scales as described by Perrier in *Nectria ocellifera*, Lamarck. The madreporiform body is distinctly visible, and the paxillæ in its neighbourhood are not very high. It will thus be seen that in the length of the ray and in the character of the paxillæ this example conforms to the description of *Nectria ocellata*, whilst in the character of the adambulacral armature it resembles that of *Nectria ocellifera*.

I may mention that I have seen a specimen in the Berlin Museum which also seemed to combine the characters of the two forms. These circumstances are not without significance in connection with what follows on the features of the young stages of the form collected by the Challenger.

[1] Révis. Stell. Mus., p. 188 (*Archives de Zool. expér.*, 1876, t. v. p. 4).

Young Phases.—In a small specimen in which R=23 mm. (about), and r=10 mm., the rays are much shorter and flatter, broader at the base and comparatively less tapering; the elevated character of the paxillæ is only just beginning to show itself, the prominence of the larger radial paxillæ being only slightly larger than the rest. The armature of the adambulacral plates is arranged in three regular and distinct rows, with three spinelets or granules in each; the furrow series being the longest and most spiniform, and the second series slightly oblique. The actinal surface is remarkable for the large size, distinctness, and regularity of the plates. This example is drawn on Pl. LV. figs. 3 and 4.

In a slightly earlier stage the rays are still flatter and the abactinal plates cannot be said to be tabulate or paxilliform at all. At the base of the rays there is a slight prominence, which is emphasised by a depression in the median interradial line. Small incipient pedicellariæ may occasionally be seen in the marginal series of a few of the large paxillæ in this and the above-mentioned stage. This is particularly interesting as their presence in the adult is very doubtful and obscure, but traces may be detected here and there of their former existence, as shown in this stage.

At a still earlier stage, when R = 13 mm., r = 6 mm., the prominence at the base of the rays above mentioned extends as a median carination throughout the ray, and culminates near the centre of the disk in a slight conical peak, in the centre of which the anal aperture is situated.

In the smallest example, which measures R = 10 mm., r = 5·5 mm., the flatness of the rays and the median carination are striking features. The abactinal plates are low, circular, and with moderately large papular interspaces; their granulation is uniform and rather widely spaced. The terminal plate is large and tubercular; and bears two stumpy, conical, spiniform papillæ. The character of the whole abactinal area is essentially Pentagonastrid, and bears no resemblance to the strikingly marked features of the adult *Nectria*. The marginal plates are broad and well-developed both on the abactinal and actinal areas. The armature of the adambulacral plates represents three series, the furrow series and that next behind having three spinelets or granules in each, whilst the outer series is often represented by only one. The obliquity of the median series is very considerable, the adoral spinelet of the series being often in the place of a spinelet of the outer series. In the furrow series there is a tendency for the adoral spinelet to be rather less than the others, and on the larger plates on the inner half of the ray the rudiment of a minute fourth spinelet may be present on the edge of the plate behind the adoral furrow spine.

Remarks.—It will be seen from the foregoing that the adult example conforms in the length of the ray and in the shape and granulation of the paxillæ to the form described as *Nectria ocellata*, whilst in the character of the adambulacral armature it corresponds to that of *Nectria ocellifera*. On the other hand the small examples, whilst corresponding to *Nectria ocellifera* in the shortness of the ray, have the adambulacral armature similar

to that described in *Nectria ocellata*. This singular admixture of characters in the adult and in the young forms has made me hesitate before referring these examples to *Nectria ocellata*, and has, at least in my mind, thrown a doubt upon the validity of the separation of *Nectria ocellata* as a species distinct from *Nectria ocellifera*. As this can only be settled by the study of a larger series of both old and young forms than I have been able to consult, I have referred the examples under notice to the original species, *Nectria ocellifera*.

Subfamily Goniodiscinæ, Sladen, 1888.

Genus *Stellaster*, Gray.

Stellaster, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 277.
Goniaster (subgen. *Stellaster*), von Martens, Archiv f. Naturg., 1865, Jahrg. xxxi., Bd. i. p. 356.
Pentagonaster (subgen. *Stellaster*), Perrier, Révis. Stell. Mus., p. 196 (Archives de Zool. expér., 1876, t. v. p. 12).

I consider that this genus well merits independent recognition, and that in any case its structural characters do not justify its being regarded as a mere subdivision of the genus *Pentagonaster*, unless the limits of that genus are made much more extended than has ever yet been proposed by any classifier. To take such a step would be in my opinion to ignore altogether what should be recognised as the characters of a genus, and would almost necessitate a reversion to the old idea of a genus founded on single arbitrary characters rather than on the consideration of the affinities and differences of its morphological structure as a whole.

Stellaster is in many respects structurally related to *Goniodiscus*, as limited by M. Perrier, and I have placed them in the same subfamily.

Chorology of the Genus Stellaster.

α. Geographical distribution:—

Pacific: Two species between the parallels of 40° N. and 20° S.
Stellaster equestris and *Stellaster tuberculatus* from China; the former also from Japan and Formosa, and extending to Australia.

Eastern Archipelago: Five species between the parallels of 20° N. and 20° S.
Stellaster equestris (which extends northward to China and Japan), *Stellaster granulosus*, *Stellaster squamulosus*, and *Stellaster incei*, from Australia; the last named also from Amboina, New Guinea, and Sumatra. *Stellaster incei* was collected by the Challenger in Torres Strait and the Arafura Sea, and amongst the Philippine group. *Stellaster princeps* from Torres Strait.

β. Bathymetrical range: As at present known all the species are confined to the Littoral zone: the greatest recorded depth is *Stellaster squamulosus*, 60 fathoms.

γ. *Nature of the Sea-bottom: Stellaster incei* was collected by the Challenger on Coral mud, Green mud, and Blue mud, all in shallow depths (from 6 to 28 fathoms), thus showing a considerable variation in habitat. A large series of specimens of *Stellaster incei* in the British Museum, dredged by the "Alert," are from depths varying from 4 to 36 fathoms, the nature of the bottom being recorded as sand and mud. *Stellaster princeps* was collected on Coral mud. The nature of the bottom is unknown to me in the case of the other species of this genus.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Stellaster equestris . .	Pacific and Eastern Archipelago.	...	... ...
Stellaster granulosus . .	Eastern Archipelago.	....	... ...
Stellaster incei . . .	Eastern Archipelago.	4 to 36	Coral mud, Green mud, Blue mud.
Stellaster princeps . .	Eastern Archipelago.	6	Coral mud.
Stellaster squamulosus .	Eastern Archipelago.	60	... ...
Stellaster tuberculosus .	Pacific.	...	... ...

1. *Stellaster incei*, Gray.

Stellaster incei, Gray, 1847, Proc. Zool. Soc. Lond., Part xv. p. 76.
Stellaster belcheri, Gray, 1847, Proc. Zool. Soc. Lond., Part xv., p. 76.
Stellaster gracilis, Möbius, 1859, Neue Seesterne des Hamburger und Kieler Museums, p. 12, Taf. iv. figs. 3 and 4 (Abhandl. a. d. Gebiete Naturw. hrsg. v. d. naturwiss. Verein, Hamburg, Bd. iv. Abth. 2, 1860).

Localities.—Station 186. In Torres Strait, off Cape York. September 8, 1874. Lat. 10° 30′ 0″ S., long. 142° 18′ 0″ E. Depth 8 fathoms. Coral mud. Surface temperature 77°·2 Fahr.

Station 187. Booby Island, Torres Strait. September 9, 1874. Lat. 10° 36′ 0″ S., long. 141° 55′ 0″ E. Depth 6 fathoms. Coral mud. Surface temperature 77°·7 Fahr.

Station 188. In the Arafura Sea, near the entrance to Torres Strait. September 10, 1874. Lat. 9° 59′ 0″ S., long. 139° 42′ 0″ E. Depth 28 fathoms. Green mud. Surface temperature 78°·5 Fahr.

Station 208. Off the east point of Panay Island, Philippine group. January 17, 1875. Lat. 11° 37′ 0″ N., long. 123° 31′ 0″ E. Depth 18 fathoms. Blue mud. Surface temperature 81°·0 Fahr.

A fine series of specimens of a species of *Stellaster* was obtained by the Challenger from several localities in the Eastern Archipelago. The large specimens from Booby Island are

unquestionably characteristic examples of the form named *Stellaster incei* by Gray; whilst smaller examples from the same locality would, if studied independently, be referred with little hesitation to his *Stellaster belcheri*. The specimens from the other localities are small, and have all the characters of young *Stellaster belcheri*.

The number of tubercle-bearing plates varies considerably, and their position is by no means constant. Some examples of *Stellaster incei* have the disk much more convex and elevated than others; the tumidity is consequently not a reliable character. I am unable to point out any real specific difference between *Stellaster incei* and *Stellaster belcheri*, and I am constrained to believe that they are growth stages of the same form. I have acted on this impression in my determination of the Challenger material, and I have preserved the name of the adult form. If my assumption is correct, the name *Stellaster belcheri* should be ranked as a synonym.

The young form (*Stellaster belcheri*) has been ably described and figured by Lütken;[1] and I would only remark that the apertures of the papulæ pores in the young of this form are guarded by a rim of squamules or granules as noted by Lütken, who states that they are "omgivne af en lille Kornkreds hver." This structure has been regarded by Studer[2] as a special characteristic of his *Stellaster squamulosus*, which also appears to me to be an immature form.

2. *Stellaster princeps*, n. sp. (Pl. LVIII. figs. 1–2).

Rays five. R = 137 mm., r = 40 mm. R < 3·5 r. Breadth of a ray near the base, between the third and fourth marginal plates, 30 mm.

Rays comparatively elongate, broad at the base, and tapering gradually throughout up to the extremity. Disk large. Interbrachial arcs widely rounded. Abactinal area regularly convex over the disk. Actinal area subplane.

The abactinal area is covered with polygonal plates which on the radial regions of the disk and the inner half of the rays are more or less incised for the papular groups, and thus assume a strikingly stellate form. About seven longitudinal series of plates may be counted at the base of the ray, about three midway along the ray, but at the tip only the median series is represented and its continuity is broken by the union of the marginal plates. The plates in the interradial areas are very large, especially a group of four external to the primary basal plate. All the plates are covered with a fine granulation imbedded in a continuous membrane. The third or fourth radial plate, counting from the centre of the disk, bears a short, robust, conical, sharply pointed tubercle, which is more or less spiniform. Five or six plates further outward, near the base of the ray, is a similar but slightly smaller tubercle, or there may be as many as three to five at irregular distances apart.

[1] *Videnskab. Medd. naturh. Foren. i Kjøbenhavn*, 1871, p. 247, pl. v. fig. 3.

[2] *Anhang z. d. Abhandl. d. k. preuss. Akad. d. Wiss. Berlin*, vom Jahre 1884, p. 33, Taf. iv. figs. 6*a*–6*c*.

The radial plates internal to the large tubercle generally bear a small tubercle; and no other plates in the median radial series are thus armed. Many of the plates in the two longitudinal series on each side of the median radial series bear similar and more or less conical tubercles. These tubercles form more or less definite lines, which gradually converge towards the centre and mark out a lanceolate figure in each radial area.

The supero-marginal plates, which are twenty-two in number, counting from the median interradial line to the extremity, form a broad well-defined border. Each plate is distinctly and prominently tumid, and all are covered with the same uniform granulation and skin as that already described on the abactinal plates. Three or four of the supero-marginal plates on each side of the median interradial line bear a single small and more or less conical tubercle on the convexity between the abactinal and lateral areas; and these tubercles are much more conspicuous and relatively larger in small examples. The terminal plate is small, rounded, subovate, and widest posteriorly.

The infero-marginal plates correspond to the superior series and are similarly tumid, but to a less degree. They are covered with a similar granulation and membrane. Each plate, except those near the end of the ray, bears three large, robust, slightly flattened lateral spines, which are disposed in an oblique line passing from the upper margin to the aboral margin. The upper or outermost spine is the largest, and measures 8 or 9 mm.; the second is rather smaller; and the third or innermost is not more than one half the size of the largest, and may be less. All are robust at the base and taper to the extremity; the two largest are usually obtuse at the tip, and the innermost is pointed. The direction of these spines is upward and outward, and they have an appressed posture, as much as the tumidity of the plate will allow. At the end of the ray only two lateral spines are present, and these are small. There are also only two spines on the first two plates in the inter-brachial arc.

The adambulacral plates are small and their armature consists of:—(1.) A furrow series of seven or eight short lamelliform spinelets, bluntly rounded at the tip; these spinelets stand more or less palisade-like, and their greatest surface is at right angles to the furrow. (2.) On the actinal surface of the plate are two large, equal-sized, flattened, and somewhat gouge-shaped or elongately spatuliform spinelets, which stand side by side, and occupy the whole breadth of the plate, forming a line parallel to the furrow series. The largest measure nearly 4 mm. in length. On the outer part of the ray (about the last third) only one actinal spine is present. Between the furrow series and the actinal spines at the adoral edge of the plate is a small two-valved pedicellaria. The outer part of the plate external to the actinal spines is covered with a small uniform granulation imbedded in membrane similar to, and continuous with, that which covers the actinal intermediate plates, and in fact all the surface of this species.

The mouth-plates are small, slightly prominent actinally, forming a low arched keel, and their surface is covered with a granulation similar to that above described. Their

armature consists of a marginal series of about eight short, lamelliform spinelets, similar to, but larger than, those on the adambulacral plates, which increase in size as they proceed inward. On the actinal surface of each mouth-plate, near the inner end, is one spinelet, exactly similar in size and shape to the corresponding spinelets on the adambulacral plates.

The actinal interradial areas are large and occupied by intermediate plates which are comparatively large in size and few in number. All are slightly tumid and covered with the uniform granulation and membrane already referred to. Each of the plates in the series next the adambulacral plates bears a number of small, two-lipped, valvate pedicellariæ, similar to those in *Anthenea*, but uniform in height with the granulation; from three to seven are present on a plate and show no definite order of arrangement. A few of the other intermediate plates bear occasionally a similar but isolated pedicellaria. Not more than three series of intermediate plates, and perhaps a few supplementary ones, are present.

The madreporiform body, which is large and elongately oval, is situated external to the basal plate. It is bounded laterally and outwardly by two large plates; and its outer end is rather nearer the centre than midway between that point and the margin. Its surface is marked with very fine striations, which radiate with more than usual regularity from the centre to the margin.

The ambulacral tube-feet are large and have very large flat sucker-disks.

The primary apical plates are easily distinguishable on the disk:—The dorso-central, the under-basals, and the basals, the last mentioned being especially conspicuous. When the madreporiform body is placed in the right anterior interradium the anal aperture is on the right posterior side of the dorso-central plate.

Small, isolated, pincer-formed pedicellariæ, with two rather coarse jaws, are present here and there on the abactinal plates, and occasionally on the infero-marginal plates in the interbrachial arcs near the lateral spines.

Colour in alcohol, a bleached yellowish white.

Young Phase.—The smallest example collected by the Challenger which measures R = 85 mm., $r = 25$ mm., has only two lateral spines on each infero-marginal plate, and the longest of these measures about 7 mm. This specimen has twenty supero-marginal plates, and in all other essential respects corresponds to the description given above.

Locality.—Station 187. Booby Island, Torres Strait. September 9, 1874. Lat. 10° 36′ 0″ S, long. 141° 55′ 0″ E. Depth 6 fathoms. Coral mud. Surface temperature 77°·7 Fahr.

Remarks.—This species is readily distinguished from all other species of *Stellaster* by the three large lateral spines, by the tumid marginal plates, by the character of the armature of the adambulacral plates, as well as that of the actinal intermediate plates. The character of the abactinal plates points to its close affinity with *Goniodiscus*.

Genus *Leptogonaster*, Sladen.

Leptogonaster, Sladen in Narr. Chall. Exp., 1885, vol. i. p. 616.

Disk large, thin, pentagonal, capable of slight inflation. Rays moderately elongate, flat, broad at the base, tapering gradually to the extremity, and producing a widely rounded interbrachial arc. The whole abactinal area covered with a uniform granulation imbedded in membrane.

Marginal plates forming a well-defined border to the disk and rays, presenting a bevelled angular margin in the interbrachial arc, but a vertical wall on the outer half of the ray. The supero-marginal plates bear no spines. The infero-marginal plates bear on the bevelled angular margin in the interbrachial arc a longitudinal series of four or five short conical spinelets, which do not extend beyond the disk; along the ray, the infero-marginal plates bear a small tubercle or aborted spinelet, which becomes more definitely developed towards the extremity.

Abactinal area of the disk, which may be more or less inflated in the radial regions, covered with flat polygonal plates, overlaid with a uniform granulation imbedded in membrane. Papulæ numerous. Small, elongate, two-jawed pedicellariæ present here and there.

Adambulacral plates large and long: armature consisting of:—(1.) On the furrow margin a series of five to seven short, delicate spinelets, partially united by a membranous web and arranged in a semicircular comb. (2.) On the actinal surface, a single long pedicellaria at the adoral extremity; and two short conical spinelets standing side by side.

Actinal interradial areas covered with thin hexagonal intermediate plates, usually granulous, overlaid with a continuous layer of membrane. The plates adjacent to the adambulacral plates each bear a small valvate pedicellaria, resembling a subpapilliform tubercle. Small indistinct granules are present on the plates. Occasionally an inconspicuous pedicellaria is present on the plates in the inner series of intermediate plates.

Madreporiform body large and situated rather nearer the centre of the disk than midway on the interradial line.

Anal aperture subcentral.

Ambulacral tube-feet with a well-developed sucker disk.

Remarks.—I have been in considerable doubt as to the retention of this genus after the publication of M. Perrier's[1] memoir on the starfishes collected by the "Blake" Expedition. The figure given by him of *Anthenoides piercei*,[2] which is an indistinct photo-lithograph, led me to think that the present starfish and the West Indian one dredged by the "Blake" were congeneric forms; but it is expressly stated by Perrier in

[1] *Nouv. Archives Mus. Hist. Nat.*, 1884, 2e Série, t. vi. pp. 127–276.

[2] *Op. cit.*, pl. viii. fig. 1.

the diagnosis of the new genus *Anthenoides*,[1] that the abactinal skeleton is reticulated,[2] and other alliances to *Anthenea* are remarked on;—*Anthenoides*, according to its author, differing in the more feeble development of the abactinal membrane and the smaller size of the pedicellariæ, which are confined to the plates adjacent to the ambulacral furrows. The present form certainly does not conform to *Anthenoides* in these respects. Furthermore, on some important points Perrier is silent, which I hardly think would have been the case if the structures had been present in his form, whilst in others the description is not sufficiently definite or specifically pertinent to allow a comparison to be made.

Relying, therefore, on Perrier's accuracy of observation, I cannot consider that the form under notice and *Anthenoides* belong to one and the same genus. The polygonal plates of the abactinal skeleton of *Leptogonaster* can in no way be called reticulate, the valvate, tubercle-like pedicellariæ of the actinal area can scarcely be said to resemble those of *Anthenea* in their character, and the two forms of pedicellariæ on the abactinal area are also noteworthy. The alliances of *Leptogonaster* would on the whole seem to be nearer the Pentagonasteridæ.

Chorology of the Genus Leptogonaster.

α. Geographical distribution:—

Eastern Archipelago: One species between the parallels of 10° and 20°N. *Leptogonaster cristatus*, off the Philippine Islands.

β. Bathymetrical range: 100 to 115 fathoms.

γ. Nature of the Sea-bottom: Green mud.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Leptogonaster cristatus . . .	Eastern Archipelago	100 to 115	Green mud.

1. *Leptogonaster cristatus*, n.sp. (Pl. LIV. figs. 1–7).

Rays five. R = 66 mm., r = 24 mm. R = 2·75 r. Breadth of a ray between the fifth and sixth supero-marginal plates, 11·5 mm.

General form flat and depressed. Disk large and pentagonal, slightly inflated. Rays

[1] *Loc. cit.*, p. 246.

[2] In the description of the species, however, Perrier (*loc. cit.*, p. 248) speaks of "les ossicules du squelette qui sont polygonaux comme chez les *Pentagonaster*," so that I am at a loss to understand what is meant by the diagnosis.

well produced, flat, tapering to a narrow extremity. Interbrachial arcs very wide and round. Lateral wall or margin angular in the interbrachial arc and at the base of the rays, but becoming vertical on the outer part of the ray, the section of the ray being there quadrangular in consequence.

The marginal plates are well developed and form a conspicuous border to the abactinal surface. The supero-marginal plates are twenty-four in number from the median interradial line to the extremity. In the interbrachial arc the surface of the plates is only slightly curved, thus forming the bevelled slope above noticed, and the supero-marginal plates do not there attain the extreme margin in consequence of the extension of the infero-marginal plates, which are visible when the starfish is viewed from above, sometimes extending a distance nearly equal to one-third of the breadth of the supero-marginal plates,—the amount seen varying according to the posture of the rays and the relative inflation of the disk. On the outer part of the ray, however, the abactinal and lateral areas of the supero-marginal plate are at right angles to one another, with the junction abrupt and subangular. The length of the supero-marginal plates is slightly greater than the breadth throughout the ray, excepting perhaps the innermost two or three in which the dimensions are subequal or with the breadth very slightly in excess. The height of the supero-marginal plates, where they enter vertically into the lateral wall, is rather more than half the length. The surface of the plates is covered with a moderately thick membranous tissue, which is continuous over the whole abactinal area of the disk and rays, and is beset with small, uniform, rather widely spaced granules. No spines of any kind are borne on the supero-marginal plates, but towards the extremity of the ray there is a tendency towards the formation of a low tubercular elevation on the angular rounding of the plate near its aboral end. Frequently on the plates that border the disk there is one, or sometimes two or three, small pedicellariæ, having a pair of comparatively elongate pincer-formed jaws, placed in a small circular cavity.

The infero-marginal plates correspond in number and length to the superior series, and are like them covered with membranous tissue and a similar small granulation. The breadth of the innermost four plates on each side of the median interradial line is rather greater than the length, but beyond this the length is the greater dimension throughout the ray. The bevelled angular edge of the infero-marginal plates which forms the extreme margin of the disk, bears a subregular horizontal series of four or five very short, conical pointed spinelets, sometimes with one or two additional above the line and sometimes with a little irregularity. These marginal dog-tooth-like spines do not extend beyond the area of the disk. Along the ray the infero-marginal plates, have a small, poorly developed tubercule on the rounding between the actinal and lateral areas and close to the aboral end of the plate, which becomes more definitely developed towards the extremity of the ray; and is much more distinct throughout than the low incipient tubercule noticed on the outermost supero-marginal plates.

The adambulacral plates are large and long, and their armature consists of a furrow series of five to seven short, delicate, slightly tapering spinelets, which decrease slightly in length towards each end of the series, radiate slightly apart, are covered with thin membrane and united with a delicate web for some distance above the base; they have the appearance of an elegant semicircular comb. At the adoral extremity of each series, very slightly behind and on the actinal surface of the plate, is a single long pedicellaria, often longer than the nearest spinelet, and with the two jaws narrow and very slightly modified in shape from that of the spinelets. This pedicellaria, which is very constant in its position and conspicuous, is directed usually at an angle toward the mouth. On the actinal surface of the plates on the inner half of the furrow are usually two short conical spinelets, standing side by side, but sometimes only one is present; these are thick at the base and sharply pointed, and though much more robust are not longer than the furrow series. On the outer half of the ray only one spinelet is present, and its relative length is distinctly greater than those on the inner half of the ray.

The mouth-plates are large and the united pair are somewhat spade-shaped anteriorly. The plates are curved coulter-shaped, and they rise towards the median line of juncture to form an elongately oval keel or eminence, the suture being more or less imperfectly closed. Their armature consists of a furrow series of eleven marginal spines on each plate, the outermost eight being equal and of about the same size and character as the furrow series of spines on the adambulacral plates proper; the inner three spines are larger and increase in size as they approach the mouth, they are also subprismatic or quadrangular in section, stand side by side, and are directed towards the actinostome at an angle of about 45° to the plane of the actinal surface generally. On the actinal surface of the plate, behind the eight small marginal spinelets in parallel line between this series and the margin and opposite the innermost of the small marginal spines, or about the middle of the series, may be placed a pedicellaria similar to that on the free adambulacral plates, but this is not always present. The mouth-plates, like the whole of the actinal and abactinal surfaces, are covered with thin membrane and beset with a few small widely spaced granules.

The actinal interradial areas, which are large and extensive, are almost equilaterally triangular in outline, excepting the interbrachial curve. They are paved with numerous regularly arranged, thin, hexagonal plates, the whole being overlaid with a continuous layer of thin membrane through which the sutures of the plates are barely visible. The largest plates are near the mouth, the rest decrease as they recede therefrom, and the smallest are those on each side of the median interradial line at the margin. The plates in the series next to the adambulacral plates are thirteen or fourteen in number, and diminish in size as they proceed outward; the other plates of the area are arranged in lines parallel to the last named and consequently parallel to the furrow. The plates adjacent to the adambulacral plates each bear a small, robust, rather elongate, valvate pedicellaria, which

from its form might easily at first sight be mistaken for a teat-like or subpapilliform tubercule. They are covered with skin, and usually stand near the middle of the plate, and exhibit no definite posture as regards the orientation of the median cleft. Occasionally two are present on a plate. There are also on the plate small indistinct widely spaced granules, whilst on the two innermost plates there are several larger granules, nearly as large as the pedicellariæ. On the other plates, *i.e.*, in the inner part of the interradial area, there is occasionally a small pedicellaria of similar form to those just described, but much less conspicuous, and they bear similar small widely spaced granules which are larger on the plates on the inner part of the area than those near the margin.

The abactinal area of the disk and rays within the boundary of the supero-marginal plates is covered with small, thin, hexagonal plates, the whole being overlaid with a continuous layer of membrane and beset with numerous, coarse, rather well-spaced granules. It is only possible to distinguish here and there the sutures of the plates through the membrane, although the general indication of the plates is to a certain extent given by the presence of small papulæ which have passage at the angles of the plates, and thus mark out their form more or less clearly. When, however, the starfish is held up to a strong, concentrated light, the hexagonal form of the plates and their pavement-like character is well seen. A regular series extends along the median interradial line, and the rest are arranged parallel to this. The median series does not reach quite to the tip, but terminates at a short distance before this is reached, the two or three terminal supero-marginal plates touching (meeting) the corresponding plates from the opposite side. The other series do not extend so far as the median series, and die out one after the other in conformity with the taper of the ray. In the radial areas of the disk there is on each side of the median series a series of smaller plates, which extend but a very short distance beyond the base of the ray, where they die out gradually. The plates of the series external to this short series of small plates are as large as those of the median series, and are contingent with them along the ray after the disappearance of the small intermediate series. Four or five series of plates, inclusive of the small series, may be counted on each side of the median series at the base of the ray. The plates on each side of the median interradial line are comparatively large in relation to their neighbours and are not separated by papulæ. At irregular and wide intervals upon the disk are small, rather elongate, pincer-formed pedicellariæ with two narrow delicate jaws, sessile over the orifice of a foramen in the plate. There are also a few much smaller valvate pedicellariæ formed by the slight modification of two juxtaposed granules. No pincer-formed pedicellariæ are present on the large plates in the median interradial area.

The anal aperture is subcentral.

The madreporiform body, which is large, circular, and flat superficially, is situated rather nearer the centre of the disk than midway on the interradial line. The striations, which are very fine and numerous, have the appearance of radiating from the centre to the

periphery in straight lines of great regularity, the bending of the furrows being sharp and angular.

The ambulacral furrows are slightly lanceolate in form, contracting as they approach the actinostome, and again very gradually at the base of the ray as they proceed outward. The tube-feet have a well-developed sucker disk.

The terminal plate is squarely shield-shaped (pentagonal), its proximal extremity angular, its sides subparallel and straight, and the distal extremity straight and truncate, bearing two short robust conical spines directed horizontally in the direction of the prolongation of the ray. The breadth of the terminal plate is abruptly less than the breadth of the ray at its attachment, which gives it the appearance of a superadded aftergrowth.

Colour in alcohol, a bleached yellowish or ashy white.

Locality.—Station 204. Off Tablas Island, Philippine group. November 2, 1874. Lat. 12° 43′ 0″ N., long. 122° 9′ 0″ E. Depth 100 to 115 fathoms. Green mud. Surface temperature 84°·0 Fahr.

Subfamily Mimasterinæ, Sladen, 1888.

This subfamily includes only the single genus *Mimaster*, the morphological relations of which are interesting as well as important. If the mind be allowed to indulge in speculative deductions, the structure of *Mimaster* would appear to indicate a phylogenetic line of descent which passes from the Archasteridæ to the Pentagonasteridæ, and has branches to the Astropectinidæ and Solasteridæ, the lines of the series being indicated by such forms as *Leptoptychaster*, *Mimaster*, *Gnathaster*, and *Solaster*. In our ignorance of the developmental history of *Mimaster*, it is, however, premature to endeavour to construct its genealogical tree with any pretension to accuracy; and any such scheme as that above suggested can only claim to be regarded as an exercise of the imagination.

To confine our remarks to matters of fact, the mouth-plates, the actinal intermediate plates, and the general form of *Mimaster* indicate an alliance with the Pentagonasteridæ; whilst the more or less strongly marked representatives of the superambulacral plates, the fan or oar-shaped lower end of the ambulacral plates, and the structure of the abactinal plates, with their paxilliform developments, point to an affinity with the Astropectinidæ, *Leptoptychaster* being the connecting form so far as the actinal intermediate plates are concerned.

Genus *Mimaster*, Sladen.

Mimaster, Sladen, Proc. Roy. Soc. Edin., 1882, vol. xi. p. 702; Trans. Roy. Soc. Edin., vol. xxx., part ii., p. 579.

Marginal contour stellato-pentagonal. Abactinal area subject to inflation. Actinal area more or less convex. Abactinal floor composed entirely of independent paxillæ,

without subjacent calcareous reticulated skeleton. Paxillæ small and compact. Numerous papulæ in the interspaces.

Marginal plates arranged in superior and inferior series, small, and covered with very numerous spinelets similar to those of the paxillæ.

Actinal interradial areas extensive, and occupied by imbricating intermediate plates, arranged in isolated transverse columns, running from the adambulacral plates to the marginal plates: the whole area covered with a uniform epidermal layer of membrane. Each intermediate plate bears a single well-developed naked paxilla.

Adambulacral plates broader than long. Adambulacral armature consisting of numerous delicate tapering spines, irregular in disposition, forming a group which occupies the surface of the plate, the size of the spines increasing towards the furrow margin of the plate.

Mouth-plates forming a pointed mouth-angle, superficies prominent, covered with spines similar in form and character to the adambulacral spines, but larger.

Ambulacral tube-feet with a well-developed terminal disk or button, devoid of spicules.

Madreporiform body either concealed by paxillæ, or large and exposed.

No pedicellariæ of any kind are present.

Remarks.—I have placed this genus—to a certain extent, provisionally—under the family Pentagonasteridæ; for although a number of its characters indicate a position near to such forms as *Gnathaster*, I consider that much might be said against its being ranked in this family at all, and much might be advanced in favour of its being classed with the Astropectinidæ,—its resemblance in many points of structure to such forms as *Leptoptychaster* being very remarkable. As I do not feel at present in a position to clear up the doubt satisfactorily, I have placed the genus apart, though in what seems to me its most natural place, until a more definite opinion can be arrived at.

Chorology of the Genus Mimaster.

α. Geographical distribution:—

Atlantic: One species between the parallels of 55° and 65° N.
Mimaster tizardi, in the Faeröe Channel.

Pacific: One species between the parallels of 40° and 60° S.
Mimaster cognatus, off the western coast of the southern point of America.

β. Bathymetrical range: 245 to 1325 fathoms.
Greatest range of one species: *Mimaster cognatus*, 245 to 1325 fathoms.

γ. Nature of the Sea-bottom: Mimaster tizardi is found on mud; *Mimaster cognatus* on Blue mud.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Mimaster tizardi . .	Atlantic.	516 to 555	Mud.
Mimaster cognatus . .	Pacific.	245 to 1325	Blue mud.

1. *Mimaster tizardi*, Sladen.

Mimaster Tizardi, Sladen, 1882, Proc. Roy. Soc. Edin., vol. xi. p. 702; Trans. Roy. Soc. Edin., vol. xxx., part ii., p. 580, pl. xxxiv.

Rays five. R = 120 mm.; r = 54 mm. R = 2·2 r. The minor radius is thus in the proportion of 45 per cent. Breadth of a ray at the base, 58 mm.

General form large and robust. Marginal contour stellato-pentagonal. Rays short and triangular, tapering continuously from the base to the extremity, the breadth at the base of a ray greater than the minor radius of the disk, the interbrachial arc being subacute.

The abactinal surface is high and inflated over the disk, very gibbous at the base of the rays, but flattening towards the extremities. A deep furrow is formed along the median interradial line in consequence of the gibbosity, but disappears before reaching the centre of the disk. The actinal surface is more or less convex, but to a comparatively slight degree, although the feature is probably largely emphasized by the upward turning of the extremities of the rays in consequence of their posture at the time of death. Consequent on the curvature of the actinal and abactinal surfaces, the margins are very thin and of small dimensions, and are occupied entirely by the double series of small marginal plates. The thickness or perpendicular height of the two series of marginal plates together is only 4 mm.

The abactinal surface is covered with a great number of small uniform paxillæ, closely and equidistantly placed, and with a well-defined space between each, which present no definite order of arrangement, excepting in the immediate neighbourhood of the arm-angle, where a certain amount of obliquely transverse lineal disposition may be observed. The whole of the calcareous portion of the abactinal skeleton is composed entirely of paxillæ, as in the Astropectinidæ. The paxillæ consist of a cylindrical pedicle, about twice as high as broad, expanding slightly at the base, and with the distal extremity rounded and clavate, and surmounted by a crown of fifteen to twenty spinelets, which radiate apart very slightly and produce a compact form of paxillæ. The spinelets are short, delicate, and slightly taper, about equal in length to the pedicle, and sometimes less, probably owing to a certain extent to abrasion. The base of the paxillæ is quite small and thin

at the margin, where a faint tendency to develop rudiments of two or three very short radiating processes may be noticed. No calcareous union or connection exists between individual paxillæ. Numerous small papulæ occur in the interspaces, three to five being present in the quadrangle formed by four neighbouring paxillæ. Their membrane is very delicate, and they taper somewhat rapidly towards the tip, which is thickened into a small knob. Owing to the manner in which the papulæ taper, a comparatively swollen appearance is given to their lower part.

The marginal plates, which are small and subtubercular in appearance, are arranged in superior and inferior series, thirty-seven to thirty-eight plates being present in each between the median interradial line and the extremity of the ray. Each plate is rounded or boss-like externally, and covered with a great number of small spinelets similar to those of the paxillæ, which gives them a prominent cushion-like appearance. The infero-marginal plates are the largest, transversely suboval in form—the length increasing towards the summit of the interbrachial arc—and bear not less than a hundred spinelets. The supero-marginal plates are smaller, usually round, and are placed rather more aborally than the companion plate of the lower series, the pairs standing consequently slightly oblique.

The actinal interradial areas are well developed, and the intermediate plates extend up to the very extremity of the ray. The plates, which are oblong, are arranged in regular transverse and slightly oblique lines between the adambulacral plates and the marginal plates. Each series or column thus formed is isolated, being separated from the neighbouring column by a narrow space; and each plate in a column overlaps or imbricates upon the next innermost plate. The number of the columns corresponds exactly to that of the adambulacral plates, and is not in relation with that of the marginal plates. The whole actinal area is overlaid by a uniform layer of membrane, by which the shape of the individual intermediate plates is hidden from superficial observation. Each intermediate plate bears a single paxilla near its free extremity, which is rather more robust than those on the abactinal surface, and carries rather fewer spinelets, which are somewhat longer and more widely expanded. The paxillæ, like those on the abactinal area, are naked and not invested with membrane. In consequence of the size and arrangement of the intermediate plates, the actinal paxillæ are more widely spaced than the abactinal ones, and are disposed in regular lines which run from the adambulacral plates to the margin, the lines or columns being marked off by straight furrows or wrinkles in the membrane. As the paxillæ are equidistantly spaced in each of these transverse rows, equally regular and uniform longitudinal lines are also traceable along the ray. In the interbrachial arc nine or ten paxillæ stand in each transverse series, the same number being maintained until about the outer fifth of the furrow.

The adambulacral plates are broader than long, and appear to stand on the furrow margin as the terminal plates of the transverse series of actinal intermediate plates;

about seventy-five adambulacral plates may be counted along the furrow. Their armature consists of delicate tapering spines, irregular in number and disposition, forming a compact group, which occupies the whole surface of the plate, transversely elongate in form in relation to the direction of the ray, and resembles a compressed and enlarged paxilla. There are fifteen to twenty spinelets in each group. Two of the spinelets (sometimes three) larger than the rest, slightly flattened, and tapering to a point, stand at the margin of the furrow, their relative position being generally slightly oblique. The succeeding spinelets are less robust, and pass in gradation to the group of outermost spinelets, which are about equal in size to the paxillæ of the actinal intermediate plates. The five or six innermost adambulacral plates have much larger spinelets than the others.

The united mouth-plates form a sharp angle inwardly, and a large elongately ovoid, subtubercular swelling is developed on their superficies,—the whole surface being covered with spinelets arranged in somewhat similar series to the spinelets of the adambulacral armature, standing perpendicular, seven to eight along each side of the mouth-angle. The aboral portion of each plate is occupied by a compressed paxilliform group similar to those of the adambulacral plates.

The madreporiform body is obscure and concealed by paxillæ.

The ambulacral tube-feet, which are arranged in pairs, are robust and large, with a well-developed fleshy disk, devoid of spicules.

No traces of any form of pedicellariæ are present.

Colour in alcohol, a dirty yellowish ashy grey, or with a light brownish shade.

Localities.—"Knight Errant" Expedition:

Station 4. In the Faeröe Channel. August 10, 1880. Lat. 59° 33′ 0″ N., long. 7° 14′ 0″ W. Depth 555 fathoms. Mud. Bottom temperature 45°·4 Fahr.; surface temperature 57°·0 Fahr.

"Triton" Expedition:

Station 10. In the Faeröe Channel. August 24, 1882. Lat. 59° 40′ 0″ N., long. 7° 21′ 0″ W. Depth 516 fathoms. Bottom temperature 46°·0 Fahr.

Station 11. In the Faeröe Channel. August 28, 1882. Lat. 59° 29′ 0″ N., long. 7° 13′ 0″ W. Depth 555 fathoms. Bottom temperature 45°·5 Fahr.

Remarks.—The arrangement and appearance of the paxillæ, and the numerous papulæ interspersed, recall in a striking manner the habit of *Solaster*. On dissection, however, it is found that this appearance is deceptive and not real, and that the true structural resemblance lies in a very different and unexpected direction. In *Solaster endeca*, the form which at first sight is most nearly suggested by the dorsal covering of this species, the abactinal portion of the skeleton consists of a rather closely reticulated calcareous framework, built up of small imbricating plates, upon certain of which the paxillæ are borne. The skeleton of *Mimaster*, on the other hand, is constructed quite differently, the whole abactinal floor being composed of paxillæ alone, each of the paxillæ consisting

of a pedicle with a slightly expanded base and a rounded clavate extremity, on which the spinelets that form the crown are articulated. The expansion of the base of the paxillæ is very slight, subcircular, or irregular in outline, and usually exhibiting two or three faint prolongations. The bases of the paxillæ are closely placed, and occasionally a trace of overlapping may be found here and there. This structure is identical with that met with in the Astropectinidæ, and has hitherto been looked upon as specially characteristic of that group.

The adambulacral plates, their armature, and the mouth-plates have strictly the characters of the Pentagonasteridæ. The marginal plates are likewise suggestive of the same group, and, notwithstanding their inequality and insignificant development, approach the habit of such forms as *Gnathaster paxillosus*, Gray, sp., from which also the general outline of the body of *Mimaster tizardi* is not far removed.

The actinal intermediate plates recall in their character the intermediate plates of the Asterinidæ, whilst their arrangement also approaches in a certain degree that of some of the Pentagonasteridæ.

2. *Mimaster cognatus*, n. sp. (Pl. XLVII. figs. 3 and 4; Pl. LXII. figs. 4 and 5).

Rays five. R = 63–65 mm.; $r = 21{\cdot}5$ mm. R = 3 r. Breadth of a ray near the base, between the third and fourth infero-marginal plates, 20 mm.

General form stellato-pentagonal. Rays moderately produced, broad at the base and tapering gradually to the extremity, which is slightly upturned. Abactinal area more or less inflated, causing a puffy appearance over the disk and an irregular subcylindrical form to the rays. Actinal area subplane, but with a tendency to become convex along the ray. Interbrachial arcs wide and subacute.

The abactinal area is covered with a great number of small paxillæ, which show an obliquely transverse arrangement at the sides of the ray, especially distinct near the base, but are irregular in their disposition in the central region of the disk, along the median line of the ray, and at the extremity. The regularly disposed paxillæ are larger than the others, and all gradually diminish in size as they approach the extremity of the ray, where they become almost microscopic. The paxillæ consist of a delicate pedicle, which expands considerably at the distal extremity, and is surmounted by a crown of numerous delicate spinelets, which radiate more or less, and produce a tufted form of paxilla. The papulæ are comparatively large.

The marginal plates are small and confined to the lateral and actinal surfaces. The supero-marginal series are inconspicuous and scarcely distinguishable from the paxillæ of the abactinal area; in fact, they are unnoticeable when the starfish is viewed from above. The infero-marginal plates, which are about thirty-six in number, counting from the median interradial line to the extremity, are comparatively large and well developed, forming a

definite border to the actinal area, to which they are in reality confined. Their breadth is greater than their length, and they present a prominent narrow keel, which is closely crowded with small spinelets similar to those on the paxillæ. There are thus deep channels between adjacent plates.

The adambulacral plates are small and rather widely spaced. Their armature consists of a more or less compact wedge-shaped group of small, cylindrical, more or less tapering, subequal spinelets. Three to five stand on the furrow margin and form a very acute angle, one spinelet being at the apex; one or two similar and equal-sized spines are placed on the actinal surface of the plate within the area enclosed by the marginal series; and behind these, on the outer part of the actinal surface of the plate, may be two or three smaller and irregularly placed spinelets.

The mouth-plates, which are comparatively large and elongate, are slightly prominent actinally, with a low convexity. Their whole surface is covered with short spinelets moderately spaced, which increase in length as they approach the inner end of the plates. From seven to ten spinelets stand in the marginal series, the innermost similar to, but slightly larger than, the furrow spinelets on the adambulacral plates; the other spinelets on the mouth-plates are irregular in number and position, and the whole structure has a very echinulate appearance.

The actinal interradial areas are well developed, and are occupied by thin imbricating plates, which form isolated columns arranged in regular transverse and slightly oblique lines between the adambulacral plates and the marginal plates. All are overlaid with a uniform continuous membrane, through which the plates are not individually distinguishable, or can only be traced here and there. The intermediate plates extend far along the ray, but do not reach the tip; the numbers in the transverse columns diminishing gradually as they proceed outward. From seven to nine plates may be counted in the series adjacent to the median interradial line. Each intermediate plate bears on an elevation on its actinal surface a paxilliform group of spinelets, which are larger and coarser than those on the abactinal paxillæ. The plates adjacent to the adambulacral plates have a distinctly elongate eminence and paxilla.

In some examples these actinal paxillæ are much coarser and more compact than in others, and the central spinelets of the crown have a tendency to be more robust and prominent. Usually the spinelets are radiating and comparatively delicate.

The madreporiform body, which is large and conspicuous, is situated rather nearer the margin than midway on the interradial line. Its surface is slightly convex and often wrinkled or broken up, as if originally formed by the union of several plates. The striation furrows are very fine and radiate centrifugally, very little convolution being noticeable.

The ambulacral tube-feet are large, with a moderately developed, rounded, button-like knob at the extremity.

No pedicellariæ of any kind are present.

Colour in alcohol, a yellowish or ashy grey, with a tendency to a dirty light brown shade.

Localities.—Station 303. Off the western coast of South America, off the Chonos Archipelago. December 30, 1875. Lat. 45° 31′ 0″ S., long. 78° 9′ 0″ W. Depth 1325 fathoms. Blue mud. Bottom temperature 36°·0 Fahr.; surface temperature 54°·8 Fahr.

Station 311. Off the entrance to Smyth Channel. January 11, 1876. Lat. 52° 45′ 30″ S., long. 73° 46′ 0″ W. Depth 245 fathoms. Blue mud. Bottom temperature 46°·0 Fahr.; surface temperature 50°·0 Fahr.

Remarks.—This species bears a very close resemblance to *Mimaster tizardi* of the North Atlantic, but is readily distinguished by a number of points. The rays are more elongate and distinctly narrower at the base, and are fuller and more swollen abactinally, which gives them a distinctly subcylindrical appearance. The paxillæ are of a more radiating and stellate character, instead of compact, as in *Mimaster tizardi;* and the difference in size between the regularly and irregularly disposed paxillæ, noticed in *Mimaster cognatus,* is not discernible in the Atlantic form. The great diminution in the size of the supero-marginal plates and the increase in that of the infero-marginal plates, and their consequent general character and posture, constitute a remarkable difference in *Mimaster cognatus.* The armature of the adambulacral plates is simpler, and the actinal interradial areas are less extensive. The madreporiform body is large and exposed in *Mimaster cognatus,* whilst it is completely hidden in *Mimaster tizardi.*

A very interesting feature may here be noticed. In the abactinal skeleton of *Mimaster cognatus* the plates at the sides of the ray (*i.e.*, the bases of the paxillæ) are cruciform, with four prolongations, nearly at right angles; whilst those of the intermediate median space of the ray are stellate, usually with five points. In *Mimaster tizardi,* on the other hand, all are stellate or substellate, and those in the median area of the rays are less definitely stellate than the lateral ones, the difference being well marked.

Family Antheneidæ, Perrier, 1884.

I have followed M. Perrier in recognising this small group of forms as an independent family. Although the Antheneidæ stand clearly apart, the characters upon which their claim to family rank is based are, perhaps, somewhat artificial, or in other words, are less well defined than is the case in the allied families. Notwithstanding this circumstance, it seems to me a better course to regard them as a distinct family than either to place them as a sub-family of Pentagonasteridæ, or to separate the genera and apportion them to the families to which they have the closest superficial resemblance.

This family comprises the genera *Anthenea*, *Goniaster* (as now limited), and *Hippasteria*. It would be superfluous to draw up a synoptic table for these well-marked forms.

Genus *Anthenea*, Gray.

Anthenea, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 279.
Hosia (*pars*), Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 279.
Goniodiscus (*pars*), Müller and Troschel, System der Asteriden, 1842, p. 57.
Goniaster (*pars*), v. Martens, Archiv f. Naturg., 1865, Jahrg. xxxi., Bd. i. p. 254.

This genus maintains a very uniform facies, and shows only a relatively small amount of structural elasticity. Its area of distribution is also a comparatively limited one, as will be seen by the subjoined analysis :—

Chorology of the Genus Anthenea.

α. *Geographical distribution* :—

INDIAN OCEAN : Two species between the parallels of 20° N. and 10° S. *Anthenea articulata*, from the Seychelle Islands (this species is mentioned by Perrier as extending to China). *Anthenea acuta*, from Madras (British Museum), and extending to South Australia.

PACIFIC : Two (or three) species between the parallels of 30° N. and 40° S. *Anthenea pentagonula*, from Hong-Kong. *Anthenea articulata*, is mentioned as coming from China. *Anthenea acuta*, from Port Jackson.

EASTERN ARCHIPELAGO : One species between the parallels of 0° and 20° S. *Anthenea tuberculosa*, from Port Essington (Australia) and Torres Strait.

β. *Bathymetrical range* : All the species appear to be confined to shallow water. The Challenger examples of *Anthenea acuta* and *Anthenea tuberculosa* were taken in depths of 6 to 15 fathoms.

γ. *Nature of the Sea-bottom* : Not recorded, except in the case of *Anthenea tuberculosa*, which was taken on Coral mud.

The locality of *Anthenea flavescens* is unknown ; and that species has consequently not been included in the foregoing list. *Anthenea grayi*, which is separated by Perrier as a distinct species, looks to me very like a growth stage of *Anthenea flavescens*, and its locality is also unknown.

The starfish described by Gray under the name of *Hosia spinulosa* appears to me to belong to this genus, and is probably an immature form.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Anthenea acuta . . .	Indian and Pacific.	6 to 15	...
Anthenea articulata . .	Indian and Pacific (?).	...	...
Anthenea flavescens . .	?	...	...
Anthenea grayi . . .	?	...	...
Anthenea pentagonula .	Pacific.	...	...
Anthenea tuberculosa . .	Eastern Archipelago.	6	Coral mud.

1. *Anthenea acuta*, Perrier.

Goniodiscus acutus, Perrier, 1869, Ann. Sci. Nat., 5e Sér., t. xii. p. 280.
Anthenea acuta, Perrier, 1876, Révis. Stell. Mus., p. 275 (Archives de Zool. expér., t. v. p. 91).

Locality.—Port Jackson. Depth 6 to 15 fathoms.

2. *Anthenea tuberculosa*, Gray.

Anthenea tuberculosa, Gray, 1847, Proc. Zool. Soc. Lond., Part xv., p. 77; Ann. and Mag. Nat. Hist., vol. x. p. 198; Synop. Spec. Starf. Brit. Mus., 1866, p. 9, pl. iv. fig. 1.

Locality.—Station 187. Booby Island, Torres Strait. September 9, 1874. Lat. 10° 36′ 0″ S., long. 141° 55′ 0″ E. Depth 6 fathoms. Coral mud. Surface temperature 77°·7 Fahr.

Remarks.—A single fine example was dredged off Booby Island, which I refer to this species. The rays are rather longer and narrower than in Gray's figure; and the supero-marginal plates are not furnished with the isolated tubercles on the upper end of the plates shown in that example. They bear large granules, and in this respect resemble an example from Port Essington preserved in the British Museum, which has been referred by Perrier to Gray's species. In the Port Essington example the supero-marginal plates are not so high and broad as in Gray's figured specimen. In the character of its supero-marginal plates the example from Booby Island appears to occupy an intermediate position. The lateral series of abactinal plates on the outer part of the ray which intervene between the median radial series and the supero-marginal plates bear a small group of granules.

2*a*. *Anthenea tuberculosa*, Gray (?), juv. (Pl. LVI. figs. 5–8.)

Locality.—Torres Strait. Exact position and conditions not recorded.

Remarks.—I have placed provisionally a single small example of *Anthenea* taken in

Torres Strait as belonging to this species. The major radius measures 13 mm., and the form is far too small to permit of a definite expression of opinion as to the species. The example is figured on Plate LVI. to show the strikingly Pentagonastrid character of its abactinal plating at this stage of growth.

Genus *Hippasteria*, Gray.

Hippasteria, Gray, Ann. and Mag. Nat. Hist., vol. vi. p. 279.
Goniaster (*pars*), Agassiz, Mém. Soc. Sci. Nat. Neuchatel, 1835, t. i. p. 191.
Astrogonium (*pars*), Müller and Troschel, System der Asteriden, 1842, p. 52.

This well-marked genus is represented by only a single species. Several authors have sought to establish distinct species on the basis of what appeared to be well-marked forms, but up to the present time none of these have stood the test when compared with a good series of examples. The genus as at present known is confined to the northern area of the Atlantic.

Chorology of the Genus Hippasteria.

α. *Geographical distribution*:—

Atlantic: One species between the parallels of 40° and 80° (?) N.

Hippasteria plana,—on the eastern side: off the British Islands, Bohuslän, Finmark, Lofoten, and off the Murman coast (*fide* Danielssen and Koren). On the western side: off Cape Cod, Nova Scotia, and northward (Verrill).

β. *Bathymetrical range*: 30 to 150 fathoms.

γ. *Nature of the Sea-bottom*: Only stated in a few instances; those recorded are Clay, Gravel, and Stones.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Hippasteria plana . .	Atlantic.	30 to 150.	Clay, gravel, stones.

1. *Hippasteria plana* (Linck), Gray.

Pentaceros planus, Linck, 1733, De Stellis marinis, p. 21, tab. xii. No. 21; tab. xxxiii. No. 53.
Asterias equestris (*pars*), Linné, 1766, Systema Naturæ, ed. xii., p. 1100.
Asterias phrygiana, Parelius, 1768, K. Norske Vidensk. Selskabs Skrifter, vol. iv. p. 425, tab. xiv. figs. 1 and 2.

Asterias Johnstoni, Gray, in Johnston, 1836, Loudon's Mag. Nat. Hist., vol. ix. p. 146, fig. 21.
Hippasteria plana, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 279; Synop. Spec. Starf. Brit. Mus., 1866, p. 9.
Hippasteria Europæa, Gray, *ibid.*
Hippasteria Johnstoni, Gray, *ibid.*
Hippasteria cornuta, Gray, *ibid.*
Goniaster equestris, Forbes, 1841, Hist. Brit. Starf., p. 125.
Astrogonium phrygianum, Müller and Troschel, 1842, System der Asteriden, p. 52.
Goniaster abbensis, Forbes, 1843, Ann. and Mag. Nat. Hist., vol. xi. p. 280, pl. vii.
Astrogonium aculeatum, Barrett, 1857, Ann. and Mag. Nat. Hist., ser. 2, vol. xx. p. 47, pl. iv. figs. 4*a*, *b*.
Goniaster phrygianus, Norman, 1865, Ann. and Mag. Nat. Hist., ser. 3, vol. xv. p. 123.
Hippasteria phrygiana, Verrill, 1885, Rep. Comiss. Fish and Fisheries for 1883, p. 542, pl. xvii. fig. 47.

Localities.—Challenger Expedition:

Station 49. Off the coast of the United States, south of Halifax, Nova Scotia. May 20, 1873. Lat. 43° 3′ 0″ N., long. 63° 39′ 0″ W. Depth 85 fathoms. Gravel, stones. Bottom temperature 35°·0 Fahr.; surface temperature 40°·5 Fahr.

"Porcupine" Expedition:

Localities not recorded. Stated to be not found below the 100 fathom line.[1]

"Triton" Expedition:

Station 3. In the Faeröe Channel. August 8, 1882. Lat. 60° 39′ 30″ N., long. 9° 6′ 0″ W. Depth 87 fathoms. Bottom temperature 49°·5 Fahr.

Remarks.—The specimens from Station 49, of which there are a large number, appear to have the ray rather longer and narrower than in the examples from the eastern side of the Atlantic; and all of them are of comparatively small size.

Family Pentacerotidæ (Gray), Perrier, *emend.* 1884.

The family Pentacerotidæ, established by Gray in 1840, included thirty-two of the forty-four genera of Asteroidea recognised by him. It embraced, in addition to the forms mentioned below, representatives of the families Pentagonasteridæ, Antheneidæ, Gymnasteriidæ, Echinasteridæ, Linckiidæ, Asterinidæ, and Asteriidæ.

In M. Perrier's classification of 1876, this unwieldy and unnatural group was split up and the name Pentacerotidæ was dropped. In the new classification proposed by Perrier in 1884 the name was revived for a small section, the recognition of which as a family appears to me to be perfectly valid and natural.

The genera now included in the family Pentacerotidæ are enumerated in the following table:—

[1] Depths of the Sea, p. 119.

Synopsis of the Genera included in the Family PENTACEROTIDÆ.

A. Marginal plates conspicuous, defining the ambitus. Abactinal plates in more or less regular longitudinal series, superficially distinct.
  a. Abactinal plates regular, with more or less definite intermediate papular areas. No intercalated series of plates between the supero-marginal and infero-marginal plates. Prominent mammillated tubercles or spines may be present.
    a. With large localised mammillated tubercles or spines. Rays carinated. Supero-marginal plates small. Form stellate . . . . *Pentaceros.*
    b. With large spines only.
      α. Supero-marginal plates large. Marginal plates regular and correspondent. Form pentagonal. Rays flat, not carinated. Few spines. Large papular areas . . *Nidorellia.*
      β. Marginal plates irregular and not correspondent. Form stellate. Many spines. Single pores or very small papular areas . . . . *Amphiaster.*
  b. Abactinal plates irregular, large and small intermixed, not forming definite intermediate papular areas. An intercalated series of plates present between the supero-marginal and infero-marginal plates. No prominent mammillated tubercles or spines . . . . . *Pentaceropsis.*

B. Marginal plates hidden or inconspicuous and not visibly defining the ambitus. Abactinal plates not in superficially discernible longitudinal series.
  a. Form pentagonal. Plates usually with more or less numerous large tubercular granules.
    a. With large papular areas. No large marginal plates at the end of the ray . . . . . *Culcita.*
    b. With papulæ distributed: not in definite areas. With a pair of large marginal plates at the end of the ray . . . . . *Asterodiscus.*
  b. Form stellate. Plates devoid of large granules.
    a. Plates devoid of spines: covered with skin . . . . . *Choriaster.*
    b. Plates bearing large robust spines . . . . . *Paulia.*

Genus *Pentaceros*, Linck.

Pentaceros, Linck, De Stellis marinis, 1733, p. 21.
Pentaceros, Schülze, Betrachtung der versteinerten Seesterne und ihrer Theile, Warschau u. Dresden, 1760, p. 50.
Goniaster (*pars*), Agassiz, Mém. Soc. Sci. Nat. Neuchatel, 1835, t. i. p. 191.
Pentaceros, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 276.
Oreaster, Müller and Troschel, System der Asteriden, 1842, p. 44.

I entirely concur with Professor Perrier in the justice of maintaining Linck's name of *Pentaceros* for this genus, in preference to Müller and Troschel's name of *Oreaster*, proposed in 1842, on the ground that Linck's name had been applied by Cuvier and

Valenciennes to a genus of fishes. Those who relinquish the claim of Linck's name of *Pentaceros* for this genus of starfishes on account of 1733 being a pre-Linnean date, and on the supposition that the name does not reappear in literature in connection with this group of animals until Gray's time, seem to me to take a most arbitrary view of the requirements of nomenclature, and one which I do not consider justifiable in the present case. To those who still adhere to the letter rather than the spirit of this canon of name-priority, I would point out that *Pentaceros* was used by Schülze[1] exactly in Linck's sense in 1760, after ten editions of the Systema Naturæ had been published, and that it was also used by Schröter[2] in 1782. There is consequently no valid reason whatever for relinquishing this well-known name, and the onus of employing a term already appropriated will rest with the ichthyologists.

Chorology of the Genus Pentaceros.

a. Geographical distribution:—

Atlantic: Three species between the parallels of 30° N. and 20° S. (A fourth species is doubtfully reputed to be from the Adriatic, but its occurrence has never been verified.)

**Pentaceros dorsatus*, off the Cape Verde Islands. *Pentaceros forcipulosus*, off the Coast of Guinea (West Africa). *Pentaceros reticulatus*, from the West Indies and Brazil, and extending to Freemantle, west coast of Australia. *Pentaceros carinatus* was recorded with doubt to be from the Adriatic, but no second example of the species has since been found.

Indian and Southern Oceans: Fourteen or sixteen species between the parallels of 30° N. and 40° S.

Pentaceros mammillatus and *Pentaceros tuberculatus*, from the Red Sea, the former being also found at Mauritius, and the latter off the East Coast of Africa. (I have a strong impression that *Pentaceros tuberculatus* is only a synonym, or at most a variety, of *Pentaceros mammillatus*.) *Pentaceros hiulcus*, *Pentaceros turritus*, and *Pentaceros muricatus*, off Mauritius and Zanzibar, the last-named also off Madagascar and the Seychelle Islands; both *Pentaceros turritus* and *Pentaceros muricatus* extend into the Eastern Archipelago, the latter

[1] Betrachtung der versteinerten Seesterne u. ihre Theile. Warschau u. Dresden, 1760, p. 50.

[2] Musei Gottwaldiani Testaceorum, Stellarum marinarum et Coralliorum quæ supersunt Tabulæ (Die Conchylien, Seesterne und Meergewächse der ehemaligen Gottwaldtischen Naturaliensammlung nach den vorhandenen neun und vierzig Kupfertafeln mit einer kurzen Beschreibung begleitet von Johann Samuel Schröter). Nürnberg, 1782, p. 58.

passing also into the Pacific. *Pentaceros belli*, *Pentaceros sladeni*, and *Pentaceros grayi*, from Mauritius, the last named also from Zanzibar, and extending into the Eastern Archipelago. *Pentaceros verrucosus*, the type of which was simply recorded as from "Indien," seems to me to embrace *Pentaceros nodosus*, Gray (*non* Linné); and if this view be correct, it would include also *Pentaceros clouei* and *Pentaceros grayi*. *Pentaceros affinis*, *Pentaceros regulus*, and *Pentaceros westermanni*, from India, the last two off the west coast, but the exact locality of the first is unknown. *Pentaceros reinhardti*, from the Nicobar Islands. *Pentaceros granulosus*, *Pentaceros nodulosus*, and *Pentaceros reticulatus*, from the west coast of Australia, the last named extending into the Atlantic (West Indies and Brazil). *Pentaceros granulosus* appears to me a doubtful member of the genus.

Eastern Archipelago: Eleven species between the parallels of 20° N. and 20° S.

Pentaceros hedemanni, **Pentaceros productus*, *Pentaceros decipiens*, *Pentaceros lütkeni*, *Pentaceros troscheli*, *Pentaceros mülleri*, and *Pentaceros grayi*, from Billiton, the last named extending into the Indian Ocean to Zanzibar. *Pentaceros superbus*, from Sumatra. *Pentaceros muricatus*, from Timor, Larentuka, and Amboina, and extending into the Indian Ocean. **Pentaceros turritus*, from Amboina, Ceram, Banda, and New Guinea, and extending into the Pacific and Indian Oceans. **Pentaceros callimorphus*, from Torres Strait.

Pacific: Nine or ten species between the parallels of 30° N. and 40° S.

Pentaceros alveolatus, *Pentaceros caledonicus*, and *Pentaceros turritus*, from New Caledonia, the last named extending into the Eastern Archipelago and Indian Ocean. *Pentaceros chinensis* and *Pentaceros orientalis*, from China. *Pentaceros australis*, *Pentaceros valvulatus* and *Pentaceros gracilis*, from Australia, the last from the east coast. *Pentaceros cumingi* and *Pentaceros occidentalis*, off the west coast of America, the former from Guayaquil, the latter from Central and Northern America. I believe, however, that the two names are synonymous, and that *Pentaceros occidentalis* should consequently be disused.

β. *Bathymetrical range:* Shallow water; all confined to the Littoral zone.

γ. *Nature of the Sea-bottom:* Recorded in very few instances, probably varying considerably, but Sand or Mud in most cases.

The species collected by the Challenger are indicated in the foregoing list by an asterisk.

Chorological Synopsis of the Species herein mentioned.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Pentaceros callimorphus .	Eastern Archipelago.	6	Coral mud.
Pentaceros dorsatus . .	Atlantic.	...	... ...
Pentaceros productus . .	Eastern Archipelago.	10	Sand.
Pentaceros turritus .	Eastern Archipelago, Pacific and Indian.	6 to 28	Sand, Coral mud, Green mud.

1. *Pentaceros dorsatus* (Linné), Perrier.

Asterias dorsatus, Linné, 1753, Museum Tessinianum, p. 114, t. 9, fig. 2.
Asterias nodosa (*pars*), Linné, 1766, Systema Naturæ, ed. xii. p. 1100.
Oreaster clavatus, Müller and Troschel, 1842, System der Asteriden, p. 49.
Oreaster dorsatus, Lütken, 1865, Videnskab. Medd. naturh. Foren. i Kjøbenhavn, 1864, p. 161.
Pentaceros dorsatus, Perrier, 1876, Révis. Stell. Mus., p. 245 (Archives de Zool. expér., t. v. p. 61).

Locality.—Off Porto Praya, St. Jago (Cape Verde Islands).

Remarks.—One of the examples is remarkably fine, its dimensions being R = 147 mm.; *r* = 76 mm.

2. *Pentaceros turritus*, Linck.

Pentaceros turritus, Linck, 1733, De Stellis marinis, p. 22, tab. ii. and iii. No. 3.
Asterias nodosa, Linné (*pars*), 1766, Systema Naturæ, ed. xii. p. 1100.
Pentaceros Franklinii, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 277; Synop. Spec. Starf. Brit. Mus., 1866, p. 6, pl. 10.
Oreaster turritus, Müller and Troschel, 1842, System der Asteriden, p. 47.
Pentaceros modestus, Gray, 1866, Synop. Spec. Starf. Brit. Mus., p. 6, pl. 9.

Localities.—Station 212. Off Malanipa Island (Philippine group). January 30, 1875. Lat. 6° 54′ 0″ N., long. 122° 18′ 0″ E. Depth 10 fathoms. Sand. Surface temperature 83°·0 Fahr.

Off Samboangan (Philippine group). January 29, 1875. Depth 10 fathoms.

Off Zebu (Philippine group). On the Reefs.

Station 187. Off Booby Island, Torres Strait. September 9, 1874. Lat. 10° 36′ 0″ S., long. 141° 55′ 0″ E. Depth 6 fathoms. Coral mud. Surface temperature 77°·7 Fahr.

Station 188. In the Arafura Sea, near the entrance to Torres Strait. September 10, 1874. Lat. 9° 59′ 0″ S., long. 139° 42′ 0″ E. Depth 28 fathoms. Green mud. Surface temperature 78°·5 Fahr.

3. *Pentaceros productus*, Bell, sp., var. *tuberata*, nov.

Oreaster productus, Bell, 1884, Proc. Zool. Soc. Lond., p. 74.

Localities.—Station 212. Off Malanipa Island, Philippine group. January 30, 1875. Lat. 6° 54′ 0″ N., long. 122° 18′ 0″ E. Depth 10 fathoms. Sand. Surface temperature 83°·0 Fahr.

Off Samboangan, Philippine group. Depth 10 fathoms.

Remarks.—There are several specimens which I have referred to this species, notwithstanding the fact that they exhibit some differences which are superficially conspicuous when compared with the series of examples from Billiton preserved in the British Museum, which were described by Professor Bell. The chief difference consists in the greater prominence of the tubercles along the median radial line, which in these Philippine examples are large mammiform prominences, the larger ones on the disk terminating in a small teat-like apex; two of these are sometimes present on the first or second tubercle at the adcentral end of the series.

The granulation of the abactinal surface of the Philippine examples is generally coarser than in those from Billiton, and shows a tendency to assume the form of flattened polygonal plates here and there amongst the other granules, chiefly on the plates between the papular areas. The disk is prominently convex and its actinal surface is concave, whilst the disk of the Billiton examples is comparatively flat. This difference is probably owing to the method of preservation: the Challenger specimens having been put into spirit when collected, whilst the Billiton examples are dried, and do not appear to have been placed in any preservative medium previously.

The actinal surface and all the other details of structure not above mentioned of the Philippine specimens correspond exactly to the type examples of the species from Billiton, so admirably described by Bell. After carefully studying both series, I do not feel that the differences above noticed are sufficient to justify the specific separation of the Philippine examples. Professor Bell has kindly compared one of the latter with his types, and his opinion accords entirely with the views above expressed.

The conspicuous character of the differences noted in the Philippine examples of *Pentaceros productus*, and their persistence in all the specimens collected by the Challenger, appear to warrant the recognition of the form as a well-marked variety, which may appropriately be called var. *tuberata*.

4. *Pentaceros callimorphus*, n. sp.

Rays five. R = 278 mm.; $r = 110$. $R > 2{\cdot}5\ r$. Breadth of a ray between the sixth and seventh infero-marginal plates, 80 mm.; breadth midway between the mouth and the extremity, 60 mm.

Disk large, elevated, and regularly convex, almost semicircular in profile, its height

being about 100 mm. measured from the resting plane. Rays well produced, rather broad at the base and rather flat abactinally, tapering gradually to the extremity. The interbrachial arcs very wide and well rounded. Actinal area plane along the rays, concave within the disk.

The whole abactinal area is marked off by trabeculæ into large regular triangular papular areas, with a roundly conical tubercle at each angle. The tubercles fall into regular longitudinal lines, forming a median radial line and two parallel lines on each side. The tubercles or spinelets of the median line are not larger than the others, and all are subequal upon the disk, the primary radial ones being only the slightest shade larger than the others. The pentagon marked out by the primary radial tubercles is divided into smaller triangles with tubercles at their angles, which causes the tubercles to appear crowded there. From the base of the ray outward the tubercles diminish in size somewhat, and there is considerable irregularity in their distance apart. At the tip of the ray they become robust, crowded, and more conical. Along the ray the papular areas are apt to be irregular in form. There is a naked space devoid of tubercles and trabeculæ along the margin of the disk, and this is rounded and rather tumid, so that the supero-marginal tubercles are not normally visible along the margin of the disk and at the base of the rays when the starfish is viewed from above. The granulation consists of small granules with larger ones intermixed, the latter being more or less mammilliform, and often showing a tendency to form groups which simulate indistinct little rosettes. A few small elongate foraminal pedicellariæ are present in each area, but are not numerous. The trabeculæ are narrow, elevated, and well defined. The papulæ are numerous. The granulation mounts the bases of the tubercles, but never covers the tip, terminating with an abrupt line, which gives many of the tubercles rather an acorn-like appearance.

The supero-marginal plates, which are twenty-seven in number from the median interradial line to the extremity, are small and each bears a tubercle, which is rounded in the disk area, but becomes more conical on the outer half of the ray, while the plate which bears it is also more or less mammillated, the base of the tubercle spreading out widely and occupying nearly the whole plate.

The infero-marginal plates, which are twenty-nine or thirty in number, are confined entirely to the actinal surface, the supero-marginal plates forming the actual margin. Each plate bears a similar tubercle, which may frequently be doubled, and sometimes divided into three or four, all springing out of the one base. All the marginal tubercles have non-granulated tips like the tubercles on the abactinal surface. Elongate foraminal pedicellariæ are rather numerous on the infero-marginal plates, and are also present on the superior series. In the space between the supero-marginal and infero-marginal tubercles are a number of larger "granules," which bear a striking resemblance to paxillæ in consequence of having a circlet of smaller granules round their margin surrounding a central granule.

The armature of the adambulacral plates consists of four distinct series of spinelets. The innermost or furrow series consists of ten to twelve (normally ten) small, flattened, obtuse spinelets, which form a compact scoop-like comb, the middle spines being longest, and the outer ones very short; these spines are placed very high in the furrow, and each successive comb is separated from that on the neighbouring plate by a rather large forceps-shaped pedicellaria near the adoral end of the series. On the actinal surface of the plate is a series of four or five large robust, flat, obtuse spinelets, which stand close together, palisade-like, the series being more or less scoop-shaped owing to the slight curvature of the base line and the general rounding of the top of the series; the spinelets may also have a slight individual curvature like front teeth. These are followed by a second series of four or five, and a third series of usually three spines, both series being similar in size and character to those above mentioned. On the outer part of the plate are often three or four irregular, prominent, subprismatic granules or incipient spinelets, irregularly placed. Near the extremity of the ray the outer series are less flattened, and may show irregularity in number and position, the number being less. Between the furrow series of spinelets and the first actinal series are a number of small flat granules.

The actinal intermediate plates are covered with a rather coarse uniform granulation, and bear small, short, subconical, prominent spinelets or papilliform granules. On the second and third series of plates, behind the adambulacral plates, these spinelets are placed in a line on the plate at right angles to the furrow, from three to five in each. On the plates next the adambulacral plates the same lineal arrangement is discernible, but it is more or less masked by grouping or doubling of the line. On the remaining plates, which are near the margin, the spines are one, two, or three together; and the comparative propinquity of the groups leads to the inference that the intermediate plates are small there. It is impossible to make out any trace of the shape of the intermediate plates, the granular surface already mentioned forming a uniform level ground. On the intermediate areas of the disk, and at the base of the rays, very numerous valvate pedicellariæ are present. These form lineal series between the lines of spines above described, but on the inner part of the area become more numerous and irregular. Their length is equal to the breadth of three or four granules, or even more. Near the adambulacral plates foraminal pedicellariæ are present; and these are more numerous along the ray beyond the base, and extend on the intermediate plates there, where the valvate pedicellariæ are either absent or of very rare occurrence. Behind the mouth-plates there is some gibbosity on the actinal interradial area, and irregular spinelets are present.

The armature of the mouth-plates consists entirely of a marginal series of mouth-spines, which appear to be greatly enlarged representatives of the furrow series of spines on the adambulacral plates.

The madreporiform body, which is very large and irregularly oval in form, is situated

at about one-third of the distance from the centre to the margin. Its surface is covered with numerous and very fine striæ, and the margin is raised, which gives the organ a "put-on" appearance.

The ambulacral tube-feet are very large, and have large fleshy sucker disks.

Colour in alcohol, a bleached yellowish white.

Locality.—Station 187. Booby Island, Torres Strait. September 9, 1874. Lat. 10° 36′ 0″ S., long. 141° 55′ 0″ E. Depth 6 fathoms. Coral mud. Surface temperature 77°·7 Fahr.

Remarks.—This species shows affinities to *Pentaceros westermanni* and the group of forms allied to *Pentaceros orientalis*. *Pentaceros callimorphus* differs conspicuously from these, as well as from other members of the genus, by the character of the armature of the adambulacral plates (see foregoing description); and by the spinulation of the actinal intermediate plates,—the lineal arrangement of spinelets on the rows of intermediate plates external to the adambulacral plates on each side of the furrow imparting a very striking ornamentation to the actinal surface. The character and the uniformity of the size of the tubercles on the abactinal surface, as well as the large, regular, and well-defined papular areas, are also noteworthy.

Genus *Pentaceropsis*, n. gen.

All recent writers who have discussed the structural characters of *Pentaceros obtusatus* (Bory de Saint Vincent), Perrier, have thrown out the suggestion that its peculiarities demand generic recognition, but no one has been bold enough to actually place it apart. In taking this step now, I fear that I may incur the risk of drawing upon myself the stigma implied by the poet as merited by those whose footsteps are less timorous than those of more gifted persons! Having no desire to be accredited with wings at the expense of my convictions, I propose to call the genus *Pentaceropsis*, as indicating its affinity to *Pentaceros*. It is characterised by the generally flat form, by the presence of the intercalated series of plates between the supero-marginal and infero-marginal plates in the interbrachial arcs, and by the irregular character of the abactinal plating.

Chorology of the Genus Pentaceropsis.

α. *Geographical distribution:*—

Eastern Archipelago and (?) Indian Ocean: One species between the parallels of 20° N. and 30° S.

Pentaceropsis obtusatus, from the Philippine Islands, and also reputed to have been found at Mauritius. The latter locality appears to be doubtful.

β. *Bathymetrical range:* Shallow water.

γ. *Nature of the Sea-bottom:* Not recorded.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Pentaceropsis obtusatus ..	{ Eastern Archipelago and (?) Indian Ocean. }	Shallow water.	...

1. *Pentaceropsis obtusatus*, Bory de Saint Vincent, sp.

Asterias obtusatus, Bory de Saint Vincent, 1827, Encycl. Méthod., 10e livr. p. 140, pl. ciii.
Oreaster obtusatus, Müller and Troschel, 1842, System der Asteriden, p. 50.
Pentaceros obtusatus, Perrier, 1876, Révis. Stell. Mus., p. 249 (Archives de Zool. expér., t. v. p. 65).

Locality.—Off Zebu, Philippine group. On the Reefs. Depth and conditions not recorded.

Genus *Culcita*, Agassiz.

Culcita, Agassiz, Mém. Soc. Sci. Nat. Neuchatel, 1835, t. i. p. 192.

All the species in this genus present a remarkable similarity of facies; and each is subject to considerable variation. In some cases a greater superficial difference exists between the growth stages of a species than between forms recognised as specifically distinct. As a natural result the determination of a limited number of examples of any of the forms is attended with considerable difficulty; and much confusion exists in the labelling of specimens preserved in different museums.

Only one species of *Culcita* was collected during the Challenger Expedition, which I have referred to the *Culcita novæ-guineæ* of Müller and Troschel.

Chorology of the Genus Culcita.

a. Geographical distribution:—

Indian and Southern Oceans: Four species between the parallels of 30° N. and 40° S.

Culcita coriacea, Culcita pentangularis, and *Culcita schmideliana*, off Mozambique; *Culcita coriacea* being found also in the Red Sea, and *Culcita schmideliana* at Zanzibar, Madagascar, and Mauritius; *Culcita pentangularis* and *Culcita schmideliana* extend into the Eastern Archipelago and Pacific, although the occurrence of *Culcita schmideliana* in the Pacific is perhaps doubtful. *Culcita veneris*, from the Island of St. Paul.

Eastern Archipelago: Four species between the parallels of 10° N. and 20° S.

Culcita novæ-guineæ, off the coast of New Guinea, extending to New Hanover (*fide* Studer). *Culcita pentangularis*, from Torres

Strait, extending to Mozambique in the Indian Ocean and to the Fiji Islands in the Pacific. *Culcita schmideliana*, from Amboina, and extending into the Indian Ocean to the East Coast of Africa, and (*fide* Gray) into the Pacific to the Galapagos Islands. *Culcita grex*, from Molucca (Leyden Museum).

Pacific: Three or four species between the parallels of 30° N. and 20° S.

Culcita acutispina, from the New Hebrides. *Culcita arenosa*, from the Sandwich Islands. *Culcita pentangularis*, from the Fiji Islands, and extending into the Eastern Archipelago and the Indian Ocean. *Culcita novæ-guineæ* is recorded from New Hanover by Studer. The occurrence of *Culcita schmideliana* in the Pacific (Galapagos Islands, *fide* Gray), still needs authentication.

β. *Bathymetrical range:* Shallow water.

γ. *Nature of the Sea-bottom:* Not recorded.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Culcita arenosa	Pacific.	(?) Shallow water.	... ...
Culcita coriacea	Indian.	...	... ...
Culcita grex	Eastern Archipelago.	...	... ...
Culcita novæ-guineæ	Eastern Archipelago.	10	Sand.
Culcita pentangularis	Indian, Eastern Archipelago, and Pacific.	...	... ...
Culcita schmideliana	Indian, Eastern Archipelago, (?) Pacific.	...	... ...
Culcita veneris	Southern Ocean.	...	... ...
Culcita acutispina	Pacific.	...	... ...

1. *Culcita novæ-guineæ*, Müller and Troschel.

Culcita Novæ-Guineæ, Müller and Troschel, 1842, System der Asteriden, p. 38.
Culcita pulverulenta (Valenciennes M.S.), Perrier, 1869, Ann. Sci. Nat., 5e Sér., t. xii. p. 260.

Localities.—Off Zebu, Philippine group. On the Reefs.

Station 212. Off Malanipa Island, Philippine group. January 30, 1875. Lat. 6° 54′ 0″ N., long. 122° 18′ 0″ E. Depth 10 fathoms. Sand. Surface temperature 83°·0 Fahr.

Remarks.—Examples of this form may be selected which correspond exactly to the type of Gray's *Culcita pentangularis*. After a careful study, however, of the various examples referable to *Culcita novæ-guineæ* which I have been able to examine, I am unable to indicate any characters by which these two forms can be separated specifically,

and I have therefore referred the material now in my hands for description to the first described species.

Genus *Asterodiscus*, Gray.

Asterodiscus, Gray, Proc. Zool. Soc. Lond., 1847, Part xv. p. 75.

This genus, although a near ally of *Culcita*, is well marked, and may readily be distinguished from all other forms. The character of its abactinal tegumentary structure, and the presence of the pair of large marginal plates at the extremity of the rays, separate it generically from the other members of the family. Only one species is at present known.

Chorology of the Genus Asterodiscus.

a. Geographical distribution:—

Eastern Archipelago and Pacific: One species between the parallels of 0° and 30° N.

Asterodiscus elegans, from Samboangan and N. E. China.

β. Bathymetrical range: Shallow water.

γ. Nature of the Sea-bottom: Not recorded.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Asterodiscus elegans . .	Eastern Archipelago and Pacific.	10	... ...

1. *Asterodiscus elegans*, Gray.

Asterodiscus elegans, Gray, 1847, Proc. Zool. Soc. Lond., Part xv. p. 75; Ann. and Mag. Nat. Hist., 1847, p. 196; Synop. Spec. Starf. Brit. Mus., 1866, p. 5, pl. xii. figs. 1 and 2.

Locality.—Station 212. Off Samboangan, Philippine group. Depth 10 fathoms.

Remarks.—The example collected by the Challenger has more numerous prominent tubercles on the abactinal area than Gray's figure represents; and the median radial line is not so definite. The adambulacral armature consists of (1.) a furrow series of five spines (the adoral one small and often hidden); and (2.) on the actinal surface of the plate a transverse series of three robust, papilliform spines on the inner half of the ray and of two on the outer half (the outermost often with one small, irregular, prismatic granule on each side). A pedicellaria with two elongate jaws often stands on the adoral side of the first or second of the spines on the actinal surface of the plate, or opposite their interspace, on the middle or outer third of the furrow. Numerous pedicellariæ, with delicate

elongate jaws, often curiously curved, are present on the actinal intermediate plates. The actinal area is very knobby, with triangular subprismatic granules between the knobs; the arrangement appearing to be one larger-sized knob to each plate, sometimes accompanied by smaller ones, surrounded by irregular pinched-out granules.

Genus *Choriaster*, Lütken.

Choriaster, Lütken, Catalog des Museum Godeffroy, 1869, No. iv., p. 35; Videnskab. Medd. naturh. Foren. i Kjøbenhavn, 1871, p. 243.

This remarkable genus appears to have a comparatively limited area of distribution, being known in literature only from the Pelew and Fiji Islands. There is, however, an example in the Museum at Vienna labelled as from New Zealand; and Samboangan, in the Philippine group, is now added as a new locality by the Challenger Expedition.

Chorology of the Genus Choriaster.

α. *Geographical distribution:*—

Pacific and Eastern Archipelago: One species between the parallels of 10° N. and 50° S.

Choriaster granulatus from Samboangan in the Eastern Archipelago, and from the Pelew and Fiji Islands in the Pacific; and extending to New Zealand.

β. *Bathymetrical range:* Shallow water (10 fathoms at Samboangan).

γ. *Nature of the Sea-bottom:* Not recorded.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Choriaster granulatus	Eastern Archipelago and Pacific.	10 Shallow water.	... ...

1. *Choriaster granulatus*, Lütken.

Choriaster granulatus, Lütken, 1869, Cat. Mus. Godeffroy, No. iv. p. 35; Videnskab. Medd. naturh. Foren. i Kjøbenhavn, 1871, p. 243.

Localities.—Station 212. Off Samboangan, Philippine group. Depth 10 fathoms. Off Kandavu, Fiji Islands. Depth and conditions not recorded.

Family Gymnasteriidæ, Perrier, 1884.

The older known genera included in this family were originally classed by Perrier[1] in the Goniasteridæ. They were subsequently removed by Viguier,[2] with the exception of *Gymnasteria*, to the Asterinidæ. Latterly, in the new classification proposed by M. Perrier,[3] they were separated as an independent family, *Gymnasteria* being taken as the type form and again united with the genera which were separated from it by Viguier.

I fully concur in the course adopted by Perrier and maintain the family as established by him, notwithstanding the fact that more than one of the recently discovered genera appear to diminish considerably the difference supposed to exist between the Gymnasteriidæ and Asterinidæ.

I have added several genera to those ranked by Perrier in the Gymnasteriidæ, and of these one or two have unquestionably many affinities with the Asterinidæ; but the balance of their structural "points" seems to me to warrant their classification with the Gymnasteriidæ. To those who take the broad view of taxonomic relationship inseparable from a theory of descent involving the assumption of organic form being dependent on variation and adaptation, this interlocking, as it might be termed, of allied families need not, in my opinion, invalidate the acceptance of the independent existence of two types or families, because some of their component forms show intermediate and transitional characters. This, indeed, seems to me to be a case which might be expected to occur under favourable circumstances; although in general these intermediate phases have disappeared.

Synopsis of the Genera included in the Family Gymnasteriidæ.

A. Marginal and abactinal plates devoid of spines.

a. Abactinal plates irregular or substellate, not forming a composite reticulated mesh-work. Adambulacral armature: furrow series consisting of two spines; actinal spines one or two. Marginal plates large. A pair of specially localised pedicellariæ at the base of the rays on the abactinal surface . . . . . *Asteropsis.*

b. Abactinal plates forming a composite reticulated mesh-work. Adambulacral armature: furrow series consisting of one spine; one actinal spine. Marginal plates small, pear-shaped, obliquely placed and strongly imbricating. No localised pedicellariæ at the base of the rays . . . . . *Dermasterias.*

B. Marginal plates with spines.

a. With a medio-radial series of large spines. Supero-marginal plates forming the margin, bearing large isolated spines. Abactinal plates rounded, forming regular longitudinal series . . . . . *Gymnasteria.*

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[1] Révis. Stell. Mus., p. 27 (*Archives de Zool. expér.*, 1875, t. iv. p. 291).

[2] *Archives de Zool. expér.*, 1878, t. vii. p. 204.

[3] *Nouv. Archives Mus. Hist. Nat.*, 2e Sér., 1884, t. vi. p. 165.

b. With no median radial series. Abactinal plates not forming regular longitudinal series.
  a. Abactinal area devoid of plating. Actinal intermediate plates forming isolated bands in transverse series . . . . *Tylaster.*
  b. Abactinal area plated. Actinal area with large intermediate plates.
    α. Plates covered with membrane; usually devoid of spines or only rare isolated ones present . . . . . *Porania.*
    β. Plates usually spinous, or with the whole membrane closely crowded with miliary spinelets.
      i. Margin angular, formed entirely by the infero-marginal plates. Supero-marginal plates hidden and inconspicuous.
        1. Infero-marginal plates with a flattened comb of spinelets, which form a broad marginal fringe . . . . . *Marginaster.*
        2. Spines when borne on the marginal plates grouped and inconspicuous, not forming a marginal fringe.
          1. Papulæ single and isolated. Adambulacral armature on the actinal surface of the plate in a grouped or double series . . . *Rhegaster.*
          2. Papulæ grouped. Adambulacral armature on the actinal surface of the plate in a single series . . *Poraniomorpha.*
      ii. Margin thick. Supero-marginal and infero-marginal plates superposed. Supero-marginal plates well-developed and conspicuous, subequal to the infero-marginal plates . . . . . *Lasiaster.*

Genus *Gymnasteria*, Gray.

Asterope, Müller and Troschel, Monatsber. d. k. Akad. d. Wiss. Berlin, April 1840, p. 104 (*non* Philippi, 1840).
Gymnasteria, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 278.
Asteropsis (*pars*), Müller and Troschel, System der Asteriden, 1842, p. 62.

This genus was first recognised by Müller and Troschel in 1840 under the name of *Asterope*, the *Asterias carinifera* of Lamarck being the type form. The name *Asterope*, however, was employed by Philippi in the same year for a Crustacean genus, and was not again used by Müller and Troschel. In their System der Asteriden, published in 1842, the same type was referred to a new genus named *Asteropsis*, and with it were associated the *Asterias pulvillus* of O. F. Müller and the *Asterias vernicina* of Lamarck. These three forms, however, constitute the types of three distinct genera, two of which were established by Gray in 1840 under the names of *Gymnasteria* and *Porania*, *Asterias carinifera* of Lamarck being referred to the former, and *Asterias pulvillus*, O. F. Müller, to the latter. Gray's names have consequently priority and are now

maintained. The third form mentioned above, *Asterias vernicina*, remains the type of Müller and Troschel's genus *Asteropsis*.

Chorology of the Genus Gymnasteria.

α. Geographical distribution:—

Indian Ocean: One species between the parallels of 30° N. and 30° S.

Gymnasteria carinifera from the Red Sea and Mauritius, and extending into the Eastern Archipelago and Pacific.

Eastern Archipelago: One (or perhaps two) species between the parallels of 20° N. and 20° S.

Gymnasteria carinifera from Amboina and other islands, and extending both into the Indian and Pacific Oceans. *Gymnasteria biserrata* from Larentuka, is in my opinion a young stage of *Gymnasteria carinifera*, or at most a variety which has maintained its juvenile characters.

Pacific: One (or perhaps two) species between the parallels of 30° N. and 30° S.

Gymnasteria carinifera from New Caledonia, the Fiji Islands, the Sandwich Islands and Panama, and extending into the Eastern Archipelago and Indian Ocean. *Gymnasteria valvulata* from the Galapagos Islands is a very young form, on the specific validity of which it is somewhat hazardous to place reliance.

β. Bathymetrical range: Shallow water.

γ. Nature of the Sea-bottom: Not recorded.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.	
Gymnasteria carinifera .	Indian Ocean. Eastern Archipelago. Pacific.	Shallow water.	...	...
? *Gymnasteria biserrata* .	Eastern Archipelago.	...	...	...
? *Gymnasteria valvulata* .	Pacific.	...	...	...

1. *Gymnasteria carinifera* (Lamarck), von Martens (Pl. LII. figs. 5–8 *juv.*).

Asterias carinifera, Lamarck, 1816, Hist. nat. anim. s. vert., t. ii. p. 556.

Asterope carinifera, Müller and Troschel, 1840, Monatsber. d. k. Akad. d. Wiss. Berlin, p. 104 (*non Asterope*, Philippi).

Gymnasteria spinosa, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 278.

Gymnasteria inermis, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 278.
Asteropsis carinifera, Müller and Troschel, 1842, System der Asteriden, p. 63.
Gymnasterias carinifera, v. Martens, 1866, Archiv f. Naturg., Jahrg. xxxii. Bd. i. p. 74.
? *Gymnasterias biserrata*, v. Martens, 1866, Archiv f. Naturg., Jahrg. xxxii. Bd. i. p. 74 (*an juv.*).

Locality.—Off Kandavu, Fiji Islands. On the Reefs.

Remarks.—Two adult examples (presenting the well-known characters of this form), and one young one, were collected by the Challenger at the above-named locality. I have given drawings of the young specimen (see Pl. LII. figs. 5–8), in order to show the presence of spinelets on the infero-marginal plates, and their absence along the median line of the ray: a state of things exactly the reverse of what occurs in the adult condition. This circumstance leads me to believe that the form described by von Martens as specifically distinct under the name of *Gymnasteria biserrata*, is only the young stage of *Gymnasteria carinifera*, or at most only a variety in which the juvenile characters are maintained throughout life.

Valuable observations on the growth stages of this species, as presented by a series of examples from Mauritius, have been made by de Loriol,[1] who has also given figures, with which it will be interesting to compare those on Pl. LII. of the young example from Kandavu.

It may be remarked that some variation occurs in the spinulation of the infero-marginal plates of adult specimens from different localities. Normally in fully grown examples these plates bear no trace of spines, but in large specimens from the Red Sea (which are amongst Müller and Troschel's types in the Berlin Collection), traces of a few incipient spines are present on the outer part of the ray. Also in examples from Mozambique and from Timor the occasional spinulation of the infero-marginal plates is more pronounced. I do not, however, look upon these as anything more than local, and perhaps even individual, variations.

Genus *Porania*, Gray.

Goniaster (*pars*), Forbes, Mem. Wern. Soc., 1839, vol. viii. p. 118.
Porania, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 288.
Asteropsis (*pars*), Müller and Troschel, System der Asteriden, 1842, p. 62.

This well-marked genus was established by Gray in 1840, and the name he proposed has an incontrovertible claim for acceptance. Notwithstanding this, some recent writers have followed the terminology of Müller and Troschel, and have used the name *Asteropsis* for this genus, but I venture to think this has been done without due acquaintance with either the literature or the merits of the case. The remarks which I have made on the genus *Gymnasteria* will be sufficient to indicate the history of the question, as well as the justice of maintaining *Porania* and *Asteropsis* as independent genera.

[1] *Mém. Soc. Phys. et Hist. Nat. Genève*, 1885, t. xxix. No. 4, p. 68.

Chorology of the Genus Porania.

a. Geographical distribution:—

Atlantic: Three species,—two between the parallels of 35° and 70° N., and one between the parallels of 50° and 60° S.

Porania pulvillus, off the coasts of Scandinavia and Britain. *Porania grandis*, off the coast of the United States of North America. *Porania antarctica*, from South Georgia (*fide* Studer), and extending into the Southern Ocean.

Southern Ocean: Three species between the parallels of 40° and 60° S.

Porania glaber and *Porania antarctica*, from Kerguelen, the latter also off Marion Island, Prince Edward Island, and the Crozet Islands. *Porania spiculata*, off Heard Island, and extending into the Eastern Archipelago.

Eastern Archipelago: One species between the parallels of 0° and 10° S.

Porania spiculata, off the Arrou Islands, and extending into the Southern Ocean to Heard Island.

Pacific: One species between the parallels of 40° and 60° S.

Porania magellanica, off the coast of Patagonia, and in the Strait of Magellan.

β. Bathymetrical range: 15 to 1600 fathoms.

Greatest range of one species: *Porania antarctica*, 50 to 1600 fathoms.

γ. Nature of the Sea-bottom: Porania spiculata is found on Gravel, Volcanic mud and Green mud; *Porania magellanica* on Green sand; and *Porania antarctica* on Diatom ooze in 1600 fathoms.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Porania antarctica . .	Southern and Atlantic.	50 to 1600	Diatom ooze (1600 fathoms).
Porania glaber . .	Southern.	30 to 127	... ...
Porania grandis . .	Atlantic.	66 to 373	... ...
Porania magellanica .	Pacific.	45	Green sand.
Porania pulvillus . .	Atlantic.	15 to 106	... ...
Porania spiculata . .	Southern Ocean and Eastern Archipelago.	75 to 800	Coarse gravel, Volcanic mud and Green mud (800 fathoms).

1. *Porania pulvillus* (O. F. Müller), Norman.

Asterias pulvillus, O. F. Müller, 1788, Zool. Dan., vol. i. p. 19, tab. xix. figs. 1 and 2.
Goniaster Templetoni, Forbes, 1839, Mem. Wern. Soc., vol. viii. p. 118, pl. iv. figs. 1 and 2.
Porania gibbosa, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 288.
Asteropsis pulvillus, Müller and Troschel, 1842, System der Asteriden, p. 63.
Asteropsis ctenacantha, Müller and Troschel, 1842, System der Asteriden, p. 63.
Porania pulvillus, Norman, 1865, Ann. and Mag. Nat. Hist., ser. 3, vol. xv. p. 122.

Localities.—"Lightning" Expedition:

Off Valentia. Depth and conditions not stated.

"Porcupine" Expedition:

Station 8. Off the west coast of Ireland. Lat. 53° 15′ N., long. 11° 51′ W. Depth 106 fathoms. Bottom temperature 10°·7 C.; surface temperature 12°·3 C.

Several specimens without record of locality or depth.

"Knight Errant" Expedition:

Station 3. Off the Island of North Rona. August 3 and 4, 1880. Lat. 59° 12′ N., long. 5° 57′ W. Depth 53 fathoms.

2. *Porania antarctica*, Smith (Pl. LIX. fig. 3).

Porania antarctica, Smith, 1876, Ann. and Mag. Nat. Hist., ser. 4, vol. xvii. p. 108; Phil. Trans., Zool. Kerguelen Island, &c., 1879, vol. clxviii. p. 275, pl. xvii. fig. 1.

Localities.—Station 145. Off Marion Island. Depth 50 fathoms.

Station 145A. Off Prince Edward Island. Depth 85 to 150 fathoms.

Station 147. West of the Crozet Islands. December 30, 1873. Lat. 46° 16′ 0″ S., long. 48° 27′ 0″ E. Depth 1600 fathoms. Diatom ooze. Bottom temperature 34°·2 Fahr.; surface temperature 41°·0 Fahr.

Remarks.—A good series of this species was collected. The spiny character is present in all stages of growth. The rays are longer and more pronounced than indicated in the original figure. There is an example from the great depth of 1600 fathoms, in which I fail to find any difference worthy of note. The rays are well pronounced and narrow at the base, and the marginal spinelets are relatively longer than in the shallower water forms. The inner or furrow spines on the adambulacral plates are remarkable for being strongly channelled on the outer side, and appearing at first sight like two spines closely pressed together, especially at the base.

3. *Porania glaber*, n. sp. (Pl. LIX. figs. 1 and 2).

Rays five. R = 91 to 97 mm., $r = 35$ mm. $R > 2{\cdot}75\ r$.

Marginal contour stellato-pentagonal. Disk large. Rays moderately produced, sub cylindrical towards the extremity, and tapering to a point; in their present position more or less recurved over the disk. Interbrachial arcs wide and rounded. Abactinal surface convex, high and tumid when inflated. The lateral wall in the interbrachial arc may be

tumid, or slope slightly at a high angle to the margin, in other words, nearly vertical. Actinal surface nearly plane, the intermediate areas slightly tumid between the ambulacral furrows and the margin. Seen on the actinal side, the comparatively great length of the rays for this genus is especially noticeable. The whole surface of the starfish is covered with a thick leathery investing membrane. No spines or tubercles of any kind are present on the abactinal surface.

The marginal plates bear a single, short, flat, truncate spinelet, and occasionally two are present. These are directed horizontally. Marginal spines are not present on the outer part of the ray, and extend only a short distance beyond the disk proper.

The armature of the adambulacral plates consists of two spines,—one on the furrow margin, which is robust at the base and tapers to a point; the other on the actinal surface of the plate, which is rather longer and much larger than the furrow spine, is flat, abruptly truncate at the tip, and often fimbriate there, also often more or less gouge-shaped, with the groove on the outer side. Occasionally a supplementary outer spine is present on the median or outer part of the furrow.

On the actinal surface the membrane is traversed by channels which run from the adambulacral plates to the margin; the marginal spines appearing as if placed one at the end of each band thus marked off by the furrow-like channels.

The madreporiform body, which is rather large and suboval, is situated approximately midway between the centre of the disk and the margin. The striæ upon its surface have the appearance of more than usual regularity in their centrifugal radiation.

Papulæ numerous and generally distributed on the abactinal surface, excepting in the median interradial areas, and perhaps also, but less distinctly, on the median radial line of the rays.

The anal aperture is subcentral and closed by numerous comparatively robust papillæ.

The ambulacral tube-feet are quadriserial in the median portion of the ambulacral furrow.

Colour in alcohol, a yellowish white, often with a more or less brown shade.

Localities.—Station 149E. Off Cape Maclear, Kerguelen Island. January 21, 1874. Depth 30 fathoms.

Station 149H. Off Cumberland Bay, Kerguelen Island. January 29, 1874. Depth 127 fathoms. Surface temperature 39°·8.

Remarks.—This form is very nearly allied to *Porania antarctica*, but is distinguished by the total absence of any spines or tubercles whatever on the abactinal surface. The rays are broad at their base, and less pronounced where they spring from the disk, having in consequence less trace of any interradial constriction or depression. No marginal spines are present on the outer part of the ray of *Porania glaber*, whereas they are continuous to the extremity in *Porania antarctica*. The disproportion in length between the inner and outer spine on the adambulacral plates is not so great in *Porania glaber* as in *Porania*

antarctica. Although the two species are scarcely distinguishable when viewed on the actinal surface, the difference between them in their abactinal aspect is most striking.

I felt at first sight disposed to rank this form as only a variety of *Porania antarctica*, but from the fact that the examples of *Porania glaber* are of large size and all identical in character, also that a large series of specimens of *Porania antarctica* were collected ranging from those very young up to those equal in size to the examples of *Porania glaber*, and that all these maintain their characters without exception, I am inclined to consider the differences above noted as worthy of specific recognition.

4. *Porania spiculata*, n. sp. (Pl. LIX. fig. 4).

This form is very nearly allied to *Porania glaber*, with which it agrees in all the general points of structure. The chief difference is that in the present species the whole of the abactinal membrane is furnished with small, widely spaced, spicule-like spinelets, which are buried in the membrane, and are only to be seen with the aid of a magnifying-glass.

None of the examples attain the size of the adult *Porania glaber*. It is also to be noticed that the disk is large, and that the rays appear to proceed more abruptly from it; the abactinal surface is less convex, and incapable of the great inflation seen in *Porania glaber;* the marginal spines are relatively smaller, and have a tendency to be directed downward rather than horizontally; the outer series of spines on the adambulacral plates are robust and chisel-shaped, and do not appear to be normally more than one-third longer than the inner series, often not so much. On the median and outer part of the furrow supplemental outer spines are very frequently present, and being situated obliquely in relation to the normal outer spine, which they resemble in all respects, the appearance is produced of an oblique series of three spinelets on a plate. On the outer part of the ray this occurs on nearly every plate, and is probably normal.

Although these differences are not very striking superficially, I have been led to consider them worthy of specific recognition, after a careful study of the series of specimens belonging to this form together with those of *Porania glaber* and *Porania antarctica*. If the correctness of this view be not admitted, *Porania glaber* and *Porania spiculata* would have to be ranked as varieties of *Porania antarctica*, a course which in my opinion would demand an amount of elasticity within the scope of a species scarcely justifiable in our present knowledge of this genus.

I can detect no differences worthy of note between the example from the Arrou Islands and those from off Heard Island. One would almost feel disposed to entertain some doubt as to the accuracy of the label of the specimen from the Arrou Islands, but I have no reason to give for this suspicion excepting the presence of the species under notice in such a locality.

The colour in alcohol is a brownish grey, with traces of a dark purple tint on the largest examples, which was probably the normal colour during life.

Localities.—Station 150. Between Kerguelen Island and Heard Island. February 2, 1874. Lat. 52° 4′ 0″ S., long. 71° 22′ 0″ E. Depth 150 fathoms. Coarse gravel. Bottom temperature 35°·2 Fahr.; surface temperature 37°·5 Fahr.

Station 151. Off Heard Island. February 7, 1874. Lat. 52° 59′ 30″ S., long. 73° 33′ 30″ E. Depth 75 fathoms. Volcanic mud. Surface temperature 36°·2 Fahr.

Station 191. Off the Arrou Islands. September 23, 1874. Lat. 5° 41′ 0″ S., long. 134° 4′ 30″ E. Depth 800 fathoms. Green mud. Bottom temperature 39°·5 Fahr.; surface temperature 82°·2 Fahr.

5. *Porania magellanica*, Studer (Pl. LIX. fig. 5).

Porania magellanica, Studer, 1876, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, July, p. 459.
? *Porania patagonica*, Perrier, 1878, Nouv. Archives Mus. Hist. Nat., 2e Série, t. i. pp. 27, 50, 85.
Porania magelhaenica, Studer, 1884, Anhang z. d. Abhandl. d. k. preuss. Akad. d. Wiss. Berlin, vom Jahre 1884, p. 42.

Locality.—Station 304. South of Port Otway, Gulf of Peñas. December 31, 1875. Lat. 46° 53′ 15″ S., long. 75° 12′ 0″ W. Depth 45 fathoms. Green sand. Surface temperature 57°·2 Fahr.

Remarks.—Examples of a form which I refer to this species were collected off the western coast of Patagonia. Structurally these specimens are nearly allied to *Porania antarctica*, but the general facies is distinctly different. They accord closely in every respect with the description of *Porania magellanica*, but as I have not had an opportunity of examining the types of that species, and as Professor Studer's diagnosis is somewhat short and insufficient for this difficult genus, I sent a drawing to him of one of the Challenger specimens, and immediately received the reply that he had no doubt whatever as to the species being *Porania magellanica*.

Through the kindness of Professor Perrier I had the good fortune to see a specimen from the Strait of Magellan to which he has given the name of *Porania patagonica* (but of which no description is yet published). So far as I can judge from the brief notes made at the time, and without actually comparing specimens side by side, I believe this to be the same form. Studer[1] has also expressed a similar opinion. A number of the marginal plates within the disk area in the Challenger specimens may bear two spinelets, equal in size, and placed side by side or slightly obliquely, and often appearing like one split into two; and in a large specimen two or three plates at the summit of the interbrachial arc may have as many as three. The character appears to be constant in the examples collected by the Challenger, and Professor Studer informs me that a similar doubling of the lateral spines occurred in his examples from the Strait of Magellan (Tuesday Harbour).

[1] *Anhang z. d. Abhandl. d. k. preuss. Akad. d. Wiss. Berlin*, vom Jahre 1884, p. 42.

Genus *Marginaster*, Perrier.

Marginaster, Perrier, Bull. Mus. Comp. Zoöl. Harvard, 1881, vol. ix. No. 1, p. 16; Nouv. Archives Mus. Hist. Nat., 2e Série, 1884, t. vi. p. 229.

Two species bearing this generic name were described by Perrier in 1881, and a third species was added by the same author[1] in the following year. A short diagnosis of the genus was first given in 1884. The descriptions of these interesting forms are unfortunately so brief and general that although two of the species are figured,[2] I feel some doubt as to whether all the three belong to one genus, and I have been unable to form any clear view as to the scope of the genus. It is, therefore, not without some hesitation that I now venture to describe a small starfish dredged during the "Porcupine" Expedition as a new species of *Marginaster*, but its characters appear to me to accord so closely with those mentioned as presented by *Marginaster pectinatus*, Perrier (which I presume may be considered as the type of the genus), that I prefer to take this course rather than burden nomenclature with what might ultimately prove to be a superfluous generic name. Under these circumstances it would be premature and injudicious in me to endeavour to formulate a more complete diagnosis of the genus, on the basis of the form which I have studied, until fuller information on the previously described species is available.

Chorology of the Genus Marginaster.

α. *Geographical distribution*:—

Atlantic: Four species between the parallels of 10° and 60° N.

Marginaster pectinatus, in the Gulf of Mexico, off the coast of Yucatan. *Marginaster echinulatus*, off Barbados. *Marginaster pentagonus*, "Talisman" dredging No. 37. *Marginaster fimbriatus*, between the north of Ireland and Rockall.

β. *Bathymetrical range*: 69 to 1360 fathoms.

γ. *Nature of the Sea-bottom*: Not recorded.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.	
Marginaster echinulatus .	Atlantic.	69	...	...
Marginaster fimbriatus .	Atlantic.	1360	...	...
Marginaster pentagonus .	Atlantic.	218	...	...
Marignaster pectinatus .	Atlantic.	95	...	...

[1] Rapport sur les Travaux de la Commission chargée par M. le Ministre de l'Instruction publique d'etudier la Faune sous-marine dans les grandes profondeurs de la Méditerranée et de l'Ocean Atlantique, par M. Alphonse Milne-Edwards, Membre de l'Institut. (Extrait des *Archives des Missions scientifiques et littéraires*. Troisième série.—Tome neuvième, Paris, 1882, p. 51.)

[2] *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi. pl. i.

1. *Marginaster fimbriatus*, n. sp. (Pl. LVIII. figs. 4–6).

Rays five. R = 6 mm.; r = 5 mm., including the breadth of the marginal fringe. Thickness about 4·75 mm. at the apex.

Marginal contour pentagonal, with the sides slightly incurved and the angles rounded. Abactinal area convex, definitely keeled along the median radial lines, and with the intermediate areas slightly hollowed. Actinal area slightly convex, with the intermediate areas slightly hollowed. Margin presenting a sharp thin edge, formed by the infero-marginal plates, which extend far beyond the supero-marginal plates. Both abactinal and actinal surfaces covered with thick membrane.

The infero-marginal plates are ten in number on each side of the pentagon, or perhaps twelve if a small comb of spinelets at the radial extremity represents an independent plate. These plates, which are thin and lamelliform, are very large in proportion to the size of the test, are broader than long, and have their free margin curved outwardly and furnished with a comb of five or occasionally six short, flattened, roundly pointed, subequal spinelets, which radiate slightly apart, the base line of the series occupying the whole of the curved free margin. The posture of the fans or combs of marginal spinelets is consequently horizontal. On the abactinal surface of the plate is a row of four or five granules, parallel to the margin, and sometimes one, two, or more supplementary granules irregularly placed. The actinal surface of the plate is covered with membrane and bears no granules or spines.

The supero-marginal plates are entirely hidden by the membrane which covers the whole abactinal surface; they stand almost vertical and imbricate upon each other slightly at the abactinal or upper end, but are scooped out at the actinal end, so as to leave an interspace between each plate. These plates may bear a few conical robust granules irregularly placed.

The ambulacral furrows are almost closed. The adambulacral plates are small. Their armature consists of two small, equal spinelets, standing side by side on the furrow margin and quite hidden in the furrow; and, on the actinal surface of the plate, two much larger, flattened, pointed, and thickly skin-covered spinelets, which are obliquely placed one behind the other; the innermost one of the pair is directed over the furrow and almost touches or interlocks with the corresponding spine on the opposite side of the furrow, and the outer spine is also directed towards the furrow but is less inclined. Seen superficially the adambulacral armature appears to form two longitudinal and alternating series of spines on each side of the furrow, the innermost or marginal series being at first sight unnoticeable.

The whole actinal area is covered with membrane and is traversed by indications of faint channels passing from the marginal plates to the ambulacral furrow. The actinal intermediate plates are entirely hidden by membrane, but appear to be comparatively large. The plates adjacent to the marginal plates bear normally a small conical papilliform

spinelet, the membrane mounting the base and causing it to appear very robust and broad. There is thus a series of spinelets running parallel to the margin. One or two plates on the inner part of the area bear a similar spine, but only one appears to be regular in occurrence, and that is situated near the apex of the area.

The abactinal area is covered with thick membrane, and although the individual plates are indistinguishable, many of them appear to be comparatively large. They bear groups of small, equal, robust, papilliform granules, scarcely worthy of being called spines; and these groups have an isolated appearance. Comparatively large, isolated, single papulæ, widely spaced, are distributed over the surface, excepting a narrow area along the median radial and the median interradial lines; along the outer part of the latter is a faint channel.

The madreporiform body, which is small and circular, is situated about midway between the centre of the disk and the margin.

The anal aperture, which is large and conspicuous, is margined by small papilliform spines.

Colour in alcohol, bleached yellow, with a light brown shade in places.

Locality.—"Porcupine" Expedition:

Station 31. Between the north of Ireland and Rockall. Lat. 56° 15′ N., long. 11° 25′ W. Depth 1360 fathoms. Bottom temperature 2°·9 C.; surface temperature 13°·8 C.

Remarks.—So far as I can judge from the short descriptions of the three[1] species hitherto known, together with the figures of two of them, this form appears to me unquestionably different from any of them.

Marginaster fimbriatus differs from *Marginaster pectinatus*, Perrier, in having groups of granules on the abactinal plates; and in the absence of the comb of spinelets on the supero-marginal plates, which according to Perrier's description are present in *Marginaster pectinatus*, and similar to those on the infero-marginal plates. The armature of the adambulacral plates is also different, and the lineal series of spinelets on the actinal interradial areas parallel to the margin are wanting in *Marginaster pectinatus*.

Marginaster pentagonus, Perrier, differs in having the abactinal plates furnished with spines disposed in irregular arcs on the margin of the plates; in the large number of spines which form the comb on the marginal plates (about ten); and in the armature of the adambulacral plates.

Marginaster echinulatus, Perrier, differs in the stellate form; in the totally different character of the adambulacral armature; in the presence of two spines on each actinal intermediate plate; in having only a single row of papulæ on each side of the median radial line; and in the peculiar form of the plates which occupy the median radial line (as shown in the figure).

[1] Perhaps the starfish described by Gasco (*Rendic. R. Accad. Sci. Fis. e. Mat. Napoli*, 1876, Anno xv., fasc. 2, p. 9), under the name of *Asteropsis capreensis*, may ultimately prove to belong to this genus also.

Genus *Rhegaster*, Sladen.

Rhegaster, Sladen, Trans. Roy. Soc. Edin. 1883, vol. xxxii. p. 155.

Marginal contour subpentagonal; rays slightly produced. Abactinal surface more or less convex, actinal flat. The whole body covered with membrane beset with crowded spinelets.

Abactinal skeleton composed of irregular plates, crowded and subimbricated in places, which leave small irregularly disposed meshes. The whole skeleton hidden in a thick membrane, and furnished with a compact covering of small, uniform, crowded spinelets. Papulæ small, numerous, isolated, irregularly distributed over the whole area.

Infero-marginal plates large, forming the margin of the test. Supero-marginal plates, superficially invisible, concealed in the abactinal membrane.

Actinal interradial areas with large subregular plates, hidden by a superficial membrane, with small crowded spinelets.

Adambulacral plates broader than long. Adambulacral armature consisting of short spines thickly invested with membrane, which form a regular furrow series, and several subregular longitudinal rows externally. Tube-feet in simple pairs, with a small sucker disk.

Madreporiform body small, midway between the margin and the apex.

No pedicellariæ.

Remarks.—This genus was established for the reception of a starfish dredged during the "Triton" cruise; and I have also referred to it the form which was named by Stuxberg[1] *Solaster tumidus*, but which was afterwards ranked as an *Asterina* by Danielssen and Koren.[2]

Through the kindness of Professor Lovén, I have had the privilege of examining Dr Stuxberg's type specimens in Stockholm, and I entirely agree with Drs Danielssen and Koren in regarding the original reference of the form to *Solaster* as altogether untenable.

Chorology of the Genus Rhegaster.

a. Geographical distribution:—

Atlantic: Two species between the parallels of 60° and 85° N.

Rhegaster tumidus off Nova Zembla, Spitzbergen, the coasts of Norway and Siberia. A variety (*tuberculata*) has been described by Danielssen and Koren which occurs between Norway and Spitzbergen.

Rhegaster murrayi in the Faeröe Channel.

[1] *Öfversigt K. Svensk. Vet.-Akad. Förhandl.*, Årg. 35, 1878 (1879), No. 3, p. 31, pl. vi.

[2] *Nyt Mag. f. Naturvidensk.*, Bd. xxvi. Hft. 2, p. 182, pls. i. & ii. figs. 6–10.

β. *Bathymetrical range:* 5 to 658 fathoms.

γ. *Nature of the Sea-bottom: Rhegaster tumidus* occurs on Clay, Blue clay, and Hard ground. The bottom inhabited by *Rhegaster murrayi* is not recorded.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Rhegaster murrayi . .	Atlantic.	285 to 433	... ...
Rhegaster tumidus . .	Atlantic.	5 to 658	Clay, Blue clay, Stony ground.

1. *Rhegaster murrayi*, Sladen.

Rhegaster Murrayi, Sladen, 1883, Trans. Roy. Soc. Edin., vol. xxxii. p. 156, pl. xxvi. figs. 2–7.

Marginal contour subpentagonal; rays slightly produced; the minor radius in the proportion of 77 per cent., or as 5 : 6·5. R = 14·3 mm.; $r = 11$ mm.

Interbrachial arcs somewhat indented at the median interradial line, from whence the contour curves outward faintly, consequent on a slightly tumid swelling at the base of the ray, and is then gracefully incurved towards the tip, which is obtuse and rounded. Abactinal area high and convex over the disk, sloping down regularly to the extremity of the rays, the height at the centre of the disk being 11·75 mm. A feeble sulcus or depression is present on the outer part of the median interradial line, which emphasises the tumid character of the base of the rays. Actinal surface more or less flat, excepting that the rays are slightly turned up at their extremity, and that a rather sharp depression occurs in the interradial areas along the inner part of the median interradial line, behind the mouth-plates.

The abactinal area is covered with short delicate spinelets, all of uniform length and size, their lower portion being apparently sunken in membrane. The spinelets stand perpendicularly, and are closely placed, presenting to the naked eye the appearance of a fine and uniformly granular surface. When magnified the spines are seen to be slightly expanded or flaring outwardly, and to be composed of many rods or lamellæ, with the extremity of each individual lamella terminating in a short thorn-like point. This spinous abactinal area is punctured with numerous small but conspicuous pores, which are irregularly distributed at small but unequal distances apart over the whole area, excepting the extremities of the rays and a narrow band along the median interradial line; towards the margin the apertures are smaller, wider apart, and less frequent. Through these apertures the papulæ are protruded, and under magnification a small but definite circlet of the abactinal membrane surrounding the puncture of the papula, and unencroached upon by spinelets, may be seen. No grouping of the abactinal

spinelets occurs, which in any way indicates the outlines of the underlying plates of the abactinal floor; and the only break in this perfectly uniform covering consists of a number of most minute channel-lines which run irregularly here and there amongst the spinelets, the only one of these maintained with any regularity being a long straight channel, similar in breadth to all the others, extending along the median interradial line. The anal aperture is subcentral and distinct, and is surrounded by slightly larger spinelets. The madreporiform body is very small, round, and with numerous striæ. It is situated rather nearer to the margin than midway to the centre of the disk, and the surrounding portion of the test is slightly prominent.

The actinal interradial areas are extensive, and have their outer margin conspicuously festooned by the infero-marginal plates.

The infero-marginal plates are eight or nine in number, counting from the median interradial line to the extremity of the ray; their outer margin has a rounded contour and bears a group of eight to twelve spinelets, rather larger and more robust than those of the abactinal area above described. The plates are entirely covered with spinelets—the part which falls in the side of the ray with spinelets similar to those on the abactinal area, and the actinal portion with spines similar to those on the actinal area. When the starfish is viewed in profile, the marginal plates are seen to be clearly marked out by vertical furrows as well as by their prominent tumidity; but the junction of the infero-marginal plates with the supero-marginal plates, or indeed the presence of these latter at all, is indiscernible to superficial observation. Seen on the actinal side the marginal plates are clearly defined by well-marked channels or furrows, which run in oblique lines from the margin up to the adambulacral plates. The furrows are almost regularly parallel, hence the areas or columns they define are of nearly uniform breadth throughout. Consequent on their oblique direction a triangular space occurs in the median interradial line in the outer portion of the area, which is not conformable to the arrangement above described, the channels which traverse it converging towards the apex of the triangular space, a short distance removed from the margin of the disk.

The whole actinal area is covered with small, almost spicular, spinelets which are short, sharply pointed, and with their bases buried in membrane. The spinelets are all nearly uniform in size, rather widely spaced, and are directed outward, almost horizontally, the angle at which they stand to the actinal surface being very small.

The ambulacral furrows are narrow and almost uniform in breadth throughout. The adambulacral plates are broader than long. Their armature consists of from five to eight spines, which form (1.) a regular inner or furrow series which arches over and almost conceals the ambulacral tube-feet; and (2.) three subregular outer rows more or less clearly defined. The following is the arrangement of the spinelets on the plates. Of the inner or furrow series there are two spines on each plate, which stand side by side and slightly oblique, especially towards the end of the ray. These two spines are regular throughout the ray

and are of equal size, short, compressed, lanceolate, tapering to a sharp point, and invested with membrane, which adds to the apparent breadth of their base. The outer spines on the actinal surface of the plate are subject to a considerable amount of variation, both in number and position. Three only may be present, each placed behind the other, external to the furrow spines, forming a transverse series on the adambulacral plate; or one, two, or even all three, of these spines may be reduplified—the companion spine usually standing rather oblique. These variations do not appear to be dependent on position in the ray but may occur in any part. All the outer spines on the actinal surface of the plate are of uniform size, cylindro-conical in shape, rather obtusely pointed, and covered with membrane.

The mouth-plates form a triangular mouth-angle, not prominent or protuberant superficially, and perfectly conformable with the triangular outline of the interradial area. The mouth-aperture is completely closed, and the arrangement of the armature of the mouth-plates is suggestive of that in certain Pentagonasteridæ. The mouth-spines are short, robust, and stand perpendicularly. One odd spine is placed at the extreme angle, at the junction of the two plates of a mouth-angle, and five similar spines, all closely placed, occupy the free or furrow margin of the plate, decreasing in size as they recede from the mouth; the odd spine being the largest, the next three slightly smaller, and the two outer ones much smaller. All the spines are cylindrical, slightly tapering, and obtusely rounded at the tip. Upon the surface of the plates, and on a line with the two small outer mouth-spines, stand two short secondary or superficial mouth-spines, one on each plate, very robust at the base, conical and pointed; and further outward again a second but much smaller spine behind each of the secondary mouth-spines; this small pair perhaps belonging to the adambulacral plate adjacent to the mouth-plates. A single minute spinelet, situate on the median or sutural line of the mouth-plates, stands midway between each of the pairs of secondary mouth-spines; and no other spines of any description are present on the mouth-plates.

Remarks.—The form above described is nearly allied to *Rhegaster tumidus*, Stuxberg, sp. The following appear to be the chief points of difference. The length of the ray is much less in *Rhegaster murrayi*, the radial proportions being for *Rhegaster murrayi*, $R = 1{\cdot}3\ r$, and for *Rhegaster tumidus*, $R = 1{\cdot}9\ r$, in specimens of the same size. The rays are consequently much less defined, and are more widely expanded at the base. In *Rhegaster murrayi* the marginal contour is distinctly festooned by the infero-marginal plates, and each of these bears a group of enlarged spinelets, neither of the characters being present in *Rhegaster tumidus*. The spines of the adambulacral armature appear to be more numerous in *Rhegaster murrayi*, the armature of the mouth-plates somewhat different, the papulæ more numerously distributed on the abactinal surface, and the character of the spinelets, both on the abactinal and actinal areas, more simple.

Locality.—"Triton" Expedition:

Station 5. In the Faeröe Channel. August 10, 1882. Lat. 60° 11′ to 60° 20′ N., long. 8° 15′ to 8° 8′ W. Depth 433 to 285 fathoms. Bottom temperature 43°·5 to 40°·8 Fahr.

Genus *Lasiaster*, n. gen.

Marginal contour stellato-pentagonal or pentagonal. Abactinal surface subplane, or may be slightly inflated.

Abactinal plates subcircular, covered with membrane, bearing numerous small miliary spinelets which are more or less co-ordinated in relation to the plates. Papulæ large, isolated, widely separate, and irregularly distributed over the whole area.

Supero-marginal plates well developed and superficially visible, covered with numerous small, miliary spinelets.

Infero-marginal plates large, also covered with numerous miliary spinelets, of which a larger series may be developed at the ambital margin.

Actinal interradial areas with large regularly arranged intermediate plates, more or less hidden by a superficial membrane and bearing groups of spinelets.

Adambulacral armature consisting of (1), a short furrow series of two or three spinelets; and (2), a transverse series on the actinal surface of the plate. Or the whole armature may be disposed as a single transverse series.

Madreporiform body small, approximately midway between the centre and the margin.

Anal aperture present, subcentral.

No pedicellariæ.

Remarks.—This genus is established for the reception of a small form dredged during the "Porcupine" Expedition, which I am unable to place in any of the known genera. Its nearest alliances appear to be with *Rhegaster* and *Poraniomorpha*, and I have accordingly included it in the family Gymnasteriidæ, although in many respects an extreme form.

Lasiaster differs from *Rhegaster* and *Poraniomorpha* in the character and development of the supero-marginal plates, which are well-developed, conspicuous, and subequal to the infero-marginal plates, the two series forming a thick margin in contradistinction to the angular margin formed only by the infero-marginal plates in the two forms named. The abactinal, marginal, and actinal intermediate plates all bear isolated groups of spinelets. These characters might lead at first sight to the impression that the starfish under notice is an aberrant member of the Pentagonasteridæ, but I only regard the resemblance as superficial.

Although I have never seen any examples of the starfish described by Sars[1] under the name of *Goniaster hispidus*, I am led to believe from the careful description and drawings given by that author that his form should be referred also to the present genus.

[1] Fauna Littoralis Norvegiæ, 3die Hefte, 1877, p. 72, pl. viii., figs. 24 and 25.

Chorology of the Genus Lasiaster.

a. Geographical distribution :—

Atlantic : Two species between the parallels of 58° and 75° N.

Lasiaster hispidus, off the Lofoten Islands, and between Spitzbergen and the Scandinavian Coast. *Lasiaster villosus*, from the Faeröe Channel.

β. Bathymetrical range: 107 to 542 fathoms.

Lasiaster hispidus does not extend below the Continental zone; whereas *Lasiaster villosus* has only been found in the Abyssal zone, at least so far as at present known.

γ. Nature of the Sea-bottom: Lasiaster hispidus was dredged on Greenish clay, Stones, and Clay, during the Norwegian North Atlantic Expedition. The nature of the ground inhabited by *Lasiaster villosus* is not recorded.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Lasiaster hispidus . .	Atlantic.	107 to 300	Greenish Clay, Stones and Clay.
Lasiaster villosus . .	Atlantic.	542	... ...

1. *Lasiaster villosus*, n. sp. (Pl. LVIII. figs. 7–10).

Rays five. R = 10·5 mm.; r = 6 mm. R = 1·75 r. Breadth of a ray between the first and second infero-marginal plates, 5·25 mm.

Marginal contour stellato-pentagonal. Rays broad at the base and tapering gradually to the extremity, the interbrachial arcs being subacute. Abactinal area subplane or very slightly convex, with a faint indication of carination along the median radial line. Actinal area plane or slightly convex, the latter character probably dependent on the posture of the rays. Margin rather thick.

The abactinal area is covered with small subcircular or oval plates imbedded in membrane, on which are borne numerous small, cylindrical, equal, cilia-like spinelets, which have the appearance superficially of being indistinctly separated into confluent groups or tufts. Large, single, isolated papulæ are distributed at wide intervals apart over the area. There is a distinct narrow channel along each median interradial line.

The supero-marginal plates, which are nine or ten in number, counting from the median interradial line to the extremity, alternate more or less with the inferior series. They are covered with spinelets exactly similar to those on the abactinal plates, which present a more or less tufted character, and thus define the separate plates. These plates are vertical in the lateral wall, and are rounded on the abactinal surface, to which they form a distinct margin when the starfish is viewed from above.

The infero-marginal plates, which are nine or ten in number counting from the median interradial line to the extremity, are large and distinct, their height in the vertical lateral wall being nearly equal to, or even slightly greater than, their breadth on the actinal surface. They are covered with spines similar to those above described, but which are larger, longer, and more robust at the junction of the lateral and actinal areas of the plate, thus forming a slightly more prominent tuft at the actinal margin of the test. On the actinal area of the plate the spinelets are more widely spaced than elsewhere. The infero-marginal plates are separated on the actinal surface by distinct channels.

The adambulacral plates are broader than long; their armature consists of:—(1.) Two spines on the furrow margin, which stand side by side, are slightly divergent, and directed over the furrow, but become oblique on the outer part of the ray and finally stand one behind the other in series with the actinal spines about to be described; these spinelets are short, equal, tapering, and covered with membrane which is thick at the base. (2.) On the actinal surface of the plate is a transverse series of three short, robust, skin-covered spinelets, which radiate slightly apart in the plane of the direction of the series: these spinelets may be subequal or the outermost may be rather smaller, or one of the other two rather larger than the companion spinelets.

The mouth-plates are small and have a marginal series of five mouth-spines on each plate, the innermost two of which are a little larger than the rest. On the actinal surface of each plate is a secondary series of two or three spines, two being large and regular.

The actinal interradial areas are occupied by regularly arranged intermediate plates, the innermost series extending far along the ray. The plates bear numerous, small, tapering spinelets which have a tufted appearance in their disposition; and one or two of the central spinelets in a group may be a little larger and more robust than the others. The tufts or groups are well spaced. The plates are indicated only by the tufts of spinelets, their outline being indistinguishable in consequence of the thick investing membrane under which the plates are hidden.

The madreporiform body, which is small and circular, is situated rather nearer the centre of the disk than midway between that point and the margin.

The anal aperture is subcentral or slightly excentric, and, being surrounded by spinelets, is only distinguishable with difficulty.

The ambulacral tube-feet have sucker disks.

Colour in alcohol, a bleached yellowish white.

Locality.—"Porcupine" Expedition:

Station 47A. 1869. In the Faeröe Channel. Lat. 59° 34′ N., long. 7° 18′ W. Depth 542 fathoms. Bottom temperature 6°·5 C.; surface temperature 12°·2 C.

Remarks.—I have expressed the opinion on a preceding page that *Goniaster hispidus*, Sars, is congeneric with the present starfish. I have, however, never seen an example of *Goniaster hispidus*, but so far as I can judge from the admirable description and figures given by Sars, *Lasiaster villosus* differs from that form by the definitely prolonged rays, by the absence of the marginal fringe of spines on the infero-marginal plates, by the actinal intermediate plates bearing a group of spines instead of arc-formed series of spines, and by the different character of the adambulacral armature, which in *Lasiaster villosus* consists of a pair of spinelets on the furrow margin of the plate and a transverse series of three on the actinal surface, whereas in *Lasiaster hispidus* the armature is described as forming a transverse series only. It is to be remarked that an approximation to this arrangement occurs at the extremity of the ray of *Lasiaster villosus*, from which it may be inferred to be a juvenile character.

From its small size the type-example of *Lasiaster hispidus* is probably an immature specimen, but from the differences above mentioned I do not suppose that it belongs to the same species as the form under notice. Danielssen and Koren[1] state that large examples of *Lasiaster hispidus* (one measuring 72 mm. in diameter) have been dredged in the Drontheim Fjord by Mr Storm, but no details are given. The *Goniaster hispidus* of Sars was referred by Perrier[2] to the genus *Pentagonaster* (and placed in the subgenus *Astrogonium*), an opinion with which I am unable to agree.

Family Asterinidæ (Gray, 1840), *emend.* Perrier, 1875.

This family appears superficially to hold an intermediate position in many respects between the Phanerozonia and Cryptozonia. The marginal plates in the genera *Asterina* and *Palmipes*, although exceedingly small, essentially define the ambitus in a conspicuous manner; in other members of the family, however, they are large and superficially Phanerozonid in their character. This circumstance, taken in conjunction with the strictly limited abactinal distribution of the papulæ, and the nature of the actinal plating, appear to me to justify the classification of the Asterinidæ under the Phanerozonia. Furthermore, the alliance of some genera of the Asterinidæ with the Gymnasteriidæ is unquestionable, and their natural position would appear to be in sequence to the latter family. The general structure of the Asterinidæ, as a whole, supports these views.

I am unable to agree with the classification of Dr Viguier,[3] who includes in the

[1] Den Norske-Nordhavs Expedition, 1876–1878, Zoologi, xi. Asteroidea, Christiania, 1884, p. 58.

[2] *Nouv. Archives Mus. Hist. Nat.*, 1878, 2e Série, t. i. p. 84.

[3] *Archives de Zool. expér.*, 1878, t. vii. p. 205.

Asterinidæ the genera *Porania*, *Dermasterias*, and *Asteropsis*, which are now placed in the family Gymnasteriidæ. I maintain the composition of the family Asterinidæ as defined by Perrier[1] in 1875.

In addition to the genera enumerated by him I have included *Cycethra*, a form since described, whose structural characters seem to me to place it amongst the Asterinidæ. I have also added in the following list another genus, *Stegnaster* (n. gen.), which seems to me necessary. The type of *Stegnaster* is the starfish described by Hutton[2] under the name of *Pteraster inflatus*, and subsequently placed under *Palmipes* by Perrier.[3] I consider that the disposition of the papulæ, the membranous investment of the abactinal area (with the absence of the characteristic tufts of spines and the presence of granules), and the simple character of the armature of the adambulacral plates are sufficient to warrant the generic separation of this form from *Palmipes*. I also refer to the same genus *Asterina wesselii*, though not without some hesitation, as the examples I have seen of that species appear to me to be immature forms.

So far as I can judge from the description[4] and figure[5] of *Tremaster* given by Verrill, I consider that the genus also belongs to this family, but from want of knowledge of its structure, I am unable to say whether its affinities are nearest to *Palmipes* or *Asterina*. No remark is made by the author as to the function of the extraordinary interradial apertures, and no suggestion is offered as to whether they are in relation with papular organs, or lead to a nidamental cavity. The circumstance of their opening on both the abactinal and actinal surfaces would seem to be at variance with such a supposition.

Synopsis of the Genera included in the Family ASTERINIDÆ.

A. Marginal plates large; and superficially phanerozonid in character . . . GANERIINÆ.

a. Spinelets on the abactinal plates spiniform, disposed in paxillæ-like groups. No differentiated median band; all the abactinal plates subsimilar. Marginal plates with a vertical group of spinelets. Actinal intermediate plates with small groups of spinelets . . . . . *Cycethra.*

b. Spinelets on the abactinal plates small, often in arcuate series. A more or less distinctly defined band of slightly differently shaped plates along the median radial line. Marginal plates with a vertical single series of spines forming a sort of comb. Actinal intermediate plates with large spines (1–2) not forming a group . . . . . *Ganeria.*

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[1] Révis. Stell. Mus., p. 28 (*Archives de Zool. expér.*, 1875, t. iv. p. 292).

[2] Cat. Echin. New Zealand, 1872, p. 10.

[3] Révis. Stell. Mus., p. 291 (*Archives de Zool. expér.*, 1876, t. v. p. 211).

[4] Proc. U.S. Nat. Mus., 1879, Nov., p. 201.

[5] Rep. Commiss. Fish and Fisheries for 1883, Washington, 1885, pl. xviii. fig. 51.

B. Marginal plates equal to or smaller than the other plates.
  a. Papulæ distributed throughout the abactinal area. Abactinal plates thick, crescentiform, devoid of internal processes . . . ASTERININÆ.
    a. Abactinal plates not imbricated; covered with spines . . . *Patiria.*
    b. Abactinal plates imbricated throughout the abactinal area, or only in definite regions.
      α. Rays cylindrical, more or less elongate. Disk small. With a definitely and sharply defined band of crescentiform plates along the median area of the rays . . . . . *Nepanthia.*
      β. Rays and body flat. Disk large.
        i. Abactinal plates more or less imbricated throughout, and bearing spinelets at the free edge, or covered with granules. All the abactinal plates subsimilar . . . . . *Asterina.*
        ii. Abactinal plates imbricating only near the margin, the others spaced apart; covered with naked skin . . . . . *Disasterina.*
  b. Papulæ confined to the radial regions. Abactinal plates in the median regions stellate. Abactinal plates thin, scale-like, with elongate internal prolongations . . . . . PALMIPEDINÆ.
    a. Abactinal plates bearing tufts of spinelets. No membrane or granules. Papulæ in a single row on each side of the median radial line . . . . . *Palmipes.*
    b. Abactinal plates covered with membrane, bearing granules. No tufts of spines. Papulæ in several rows on each side of the median interradial line . . . . . *Stegnaster.*

Subfamily GANERIINÆ, Sladen, 1888.

Genus *Cycethra*, Bell.

[*Cycethra*, Bell, Proc. Zool. Soc. Lond. 1881, p. 96.

This genus was established by Professor Jeffrey Bell for the reception of a starfish discovered by Dr Coppinger in Trinidad Channel during the surveying voyage of H.M.S. "Alert" in the Strait of Magellan and on the coast of Patagonia. The remarkable combination of characters presented by that form was noticed by Bell, and duly referred to in his description; and the new species appear to fully bear out the "mixed" character of *Cycethra* as regards its morphological relationships. The genus would seem to have a limited distribution, but appears to possess a considerable amount of specific plasticity within that area. Its alliance to the very local genus *Ganeria* is striking, and when the two forms are studied together, I think there will remain little doubt that *Cycethra* and *Ganeria* are near neighbours in the zoological scale as well as in geographical position.

Chorology of the Genus Cycethra.

a. Geographical distribution:—

Atlantic: Three species between the parallels of 45° and 55° S.

Cycethra pinguis and *Cycethra nitida*, off Cape Virgins, near the Atlantic entrance to the Strait of Magellan. *Cycethra electilis*, off the Falkland Islands.

Pacific: One species between the parallels of 45° and 55° S.

Cycethra simplex, in the Trinidad Channel, west coast of Patagonia.

β. Bathymetrical range: 12 to 55 fathoms.

γ. Nature of the Sea-bottom: All the species inhabit a sandy bottom.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Cycethra electilis	Atlantic.	12	Sand and gravel.
Cycethra nitida	Atlantic.	55	Sand.
Cycethra pinguis	Atlantic.	55	Sand.
Cycethra simplex	Pacific.	30	Sand.

1. *Cycethra electilis*, n. sp. (Pl. LX. figs. 3 and 4; Pl. LXII. figs. 2 and 3).

Rays five. R = 40 mm.; r = 16 mm. R = 2·5 r. Breadth of a ray between the third and fourth infero-marginal plates, 15 mm.

Rays moderately produced and comparatively flat, broadest at the base, and tapering gradually therefrom to the extremity, which is rather broad and obtusely rounded. Disk capable of slight inflation, which may be emphasised by a faint depression in the median interradial line. Margin moderately thick and vertical. Interbrachial arcs more or less rounded. Actinal surface plane.

The abactinal area is covered with small plates which bear small paxilliform groups of spines. These are composed of from three to seven short, cylindrical, obtusely-rounded, equal spinelets, which are erect and covered with membrane, the latter forming a compact fleshy mass within the paxilla in which the spinelets are imbedded. Large and smaller paxillæ are intermixed, but the difference in size is not conspicuous at first sight, and no order of arrangement is discernible; they are distinctly spaced. Numerous papulæ are present in the interspaces, sometimes two or three together.

The marginal plates are small and confined entirely to the margin, occupying the

whole thickness of the lateral wall. The superior and inferior series alternate more or less distinctly. The plates, which are subequal and similar in size and character, bear a group of small equal-sized spinelets about twenty in number. The groups are well-spaced apart, the interspace being greater than the breadth of the group (*i.e.* length in relation to the ray), and they appear to have a vertical disposition, the height of the group being greater than the length. The spinelets are similar to those on the abactinal plates, and their bases are similarly imbedded in membrane. About twenty-five infero-marginal plates may be counted between the median interradial line and the extremity.

The adambulacral plates are small, and their armature consists of two rather short, robust, subequal, slightly tapering spinelets placed on the furrow margin of the plate, and standing slightly oblique, the adoral spinelet being more inward. On the actinal surface of the plates is an oblique series of three obtuse, cylindrical, dumpy spinelets, shorter than the furrow series. On the inner half of the ray this series forms an angle of about 45° to the line of the furrow. On the outer part of the ray the adambulacral plates are very short, and there is only one spinelet on the furrow margin, and the spinelets on the actinal surface of the plate—here reduced to little more than papilliform granules—form with it a single transverse line.

The mouth-plates are large, and their armature consists of five robust, subequal spines on the free margin of each plate. The actinal surface is plane and covered with membrane, and the only spines borne on this surface are a group of two or three placed far back near the outermost end of each plate. The marginal spinelets have a slight downward trend, which causes the united pairs of mouth-plates to have rather a scoop-shaped appearance.

The actinal intermediate plates are small and regularly arranged, forming lines parallel to the furrow, and series which run obliquely from the adambulacral to the marginal plates. Each plate bears three or four short, cylindrical, obtusely-rounded, equal, erect, papilliform spinelets, which are skin-covered and imbedded at the base, forming a definitely spaced little group, more or less paxilliform in appearance. Only the series adjacent to the adambulacral plates extends to the extremity of the ray. The other series terminate gradually along the ray: eight or nine groups may be counted at the median interradial line.

The madreporiform body, which is large, circular, and more or less convex, is situated nearer the centre than midway between that point and the margin, and there are several larger groups of spines amongst those which surround it.

The anal aperture is slightly excentric; there is no modification in the spine-groups around its periphery.

The ambulacral tube-feet have well-defined sucker-disks.

No pedicellariæ are present.

Colour in alcohol, a bleached yellowish white, with a slightly warm brownish shade.

Young Phase.—There is a young example (R = 16·5 mm.; *r* = 7·5 mm.) which presents so characteristically the structural features of the adult that it may be readily distinguished from a young specimen of the same size of *Cycethra nitida*. The abactinal paxillæ at this age are distinctly spiniform and without the appearance of being imbedded, which is such a striking feature in the adult.

Locality.—Station 315. Port William, Falkland Islands. January 26, 1876. Lat. 51° 40′ 0″ S., long. 57° 50′ 0″ W. Depth 12 fathoms. Sand, Gravel. Surface temperature 50°·0 Fahr.

Remarks.—This species presents many points of alliance to *Cycethra simplex*, Bell, but may be distinguished by the generally flatter form, by the greater breadth of the rays at the base, by the more obliquely placed pair of spinelets on the furrow margin of the adambulacral plates, and by the presence of the oblique series of three spines on the actinal surface of the plates, whereas in *Cycethra simplex* there are only two.

2. *Cycethra nitida*, n. sp. (Pl. LXI. figs. 3 and 4; Pl. LXII. figs. 10 and 11).

Rays five. R = 53 mm.; *r* = 16 mm. R = 3·3 *r*. Breadth of a ray between the fifth and sixth infero-marginal plates, 12 mm.; midway along the ray, about 7·5 mm.

Rays rather elongate and narrow, distinctly subcylindrical abactinally, and flat actinally. Disk slightly convex and capable of inflation. Lateral wall low and merged in the convexity of the rays and disk. Interbrachial arcs well rounded. Actinal area plane.

The abactinal area is covered with small plates which bear compact groups of numerous spines, large and smaller groups interspersed and all closely crowded. The spinelets are short, robust, cylindrical, obtusely-rounded and subequal, and in the larger groups there may be as many as eighteen to twenty. The groups have a more or less rounded form. No order of arrangement is discernible. Papulæ are present in the interspaces.

The marginal plates are small and confined to the margin, where, however, they do not form a definite wall in consequence of the tumid convexity of the abactinal surface of the rays and disk. The superior and inferior series alternate. The plates, which are subequal and similar in character, bear a group of small, equal spinelets which are so short that they are little more than elongate granules. The plates, which are convex and subtubercular, are suboval in form, and their posture is somewhat oblique. In the interbrachial arcs, in consequence of the tumidity of the margin, the infero-marginal series is carried quite on the actinal surface, and the supero-marginal series forms the actual margin of the disk. There are about forty supero-marginal plates between the median interradial line and the extremity.

The adambulacral plates are small, and their armature consists of a pair of short, robust, flattened, obtusely-tipped, equal spinelets on the furrow margin, which radiate slightly apart, and are directed over the furrow. On the actinal surface of the plate are

two or three pairs of much smaller papilliform spinelets, the outermost pair being very little larger than the spinelets on the actinal intermediate plates. Sometimes the disposition of the spinelets on the actinal surface is slightly oblique. The character of the arrangement of the armature as described above extends to the extremity of the ray.

The actinal intermediate plates are small and regularly arranged. Each plate bears a paxilliform group of five to eight spinelets, which are subequal in size and radiate slightly apart. The groups or paxillæ are comparatively closely crowded, which gives a compact and well-filled character to the actinal interradial areas.

The madreporiform body is scarcely visible: it appears to be normally hidden by the surrounding paxillæ.

The anal aperture is rather large and slightly excentric in position.

No pedicellariæ are present.

Colour in alcohol, a dirty ashy grey with a slightly yellowish tint.

Young Phase.—There is a small example (R = 16 mm., $r = 7{\cdot}3$ mm.) which accords so closely in general character, that I feel little doubt about its belonging to this species. The character of the abactinal paxillæ and the armature of the adambulacral plates are the same as in the adult form described above, and readily distinguish it from an equally young example of *Cycethra electilis*. It is to be remarked, however, that the rays in the young *Cycethra nitida* are much shorter, broader, and flatter than in the adult, recalling in these particulars the appearance of *Cycethra electilis*.

This young example is interesting in having in two of the mouth-angles a lineal series of four or five spines on the outer part of the actinal surface of each of the mouth-plates; the two series on a companion pair of mouth-plates are apposed to one another, and appear to form a pedicellaria-like organ, resembling to a certain degree those found in *Pararchaster* and some species of *Pontaster*.

Locality.—Station 313. Off Cape Virgins, eastern coast of South America, near the Atlantic entrance to the Strait of Magellan. January 20, 1876. Lat. 52° 20′ 0″ S., long. 67° 39′ 0″ W. Depth 55 fathoms. Sand. Bottom temperature, 47°·8 Fahr.; surface temperature, 48°·2 Fahr.

Remarks.—This species is readily distinguished from *Cycethra electilis* by the longer, narrower, and semi-cylindrical rays, by the numerous and comparatively compactly grouped spinelets in the abactinal paxillæ, by the small marginal plates, by the different arrangement of the armature of the adambulacral plates, and by the closely packed spine-groups of the actinal interradial areas. The facies of the two forms is quite different.

3. *Cycethra pinguis*, n. sp. (Pl. LXI. figs. 1 and 2; Pl. LXII. figs. 8 and 9).

Rays five. R = 100 mm.; $r = 33$ mm. $R = 3\,r$. Breadth of a ray between the sixth and seventh infero-marginal plates, 24 mm.; breadth about midway between the base and the extremity, 11·5 mm.

Disk large, convex, and much inflated. Rays elongate, narrow, and more or less rounded cylindrically. Margin rather angular, the marginal plates being very inconspicuous. Interbrachial arcs wide and rounded. Actinal surface concave and deeply depressed within the disk (possibly this is either a mere body contraction, or may indicate the formation of a nursing cavity such as occurs in some forms of *Asterias* and *Echinaster*). The actinal surface of the rays is slightly convex.

The abactinal area is covered with small irregularly disposed plates, which bear groups of from three to ten spinelets. The spinelets are short, subequal, papilliform, covered with membrane and imbedded at the base in a thick fleshy mass, the groups looking more like irregular echinulated masses than paxillæ. The form of the masses varies considerably, and elongate groups are not infrequent. Large and smaller groups are interspersed irregularly, and all are widely spaced. In the interspaces are numerous large papulæ, and groups of three to five may be counted.

The marginal plates, which are very small and quite inconspicuous, are at first sight scarcely distinguishable from the actinal and abactinal plates on the median part of the ray, and much irregularity occurs in their size. In the interbrachial arc and on the outer half of the ray they are more distinct; and the superior and inferior series are seen to alternate to a certain degree. The plates, which are subequal and similar in character, are covered with small papilliform granules, skin-covered and imbedded in membrane similar to those on the abactinal and actinal plates. More than fifty inferomarginal plates may be counted between the median interradial line and the extremity, but it is scarcely possible without dissection and preparation to count the number accurately on account of their small size and the interference of intermediate plates on the middle part of the ray.

The adambulacral plates are short, and their armature consists of:—(1.) A single large spine on the furrow margin, which is very robust and cylindrical at the base, but flattened and truncate at the tip like a chisel in the direction transverse to the axis of the ray. These spines are thickly covered with membrane. On the ten or twelve plates near the mouth there are two spines on the furrow margin, very obliquely placed, the adoral one of the pair being pushed far back. (2.) On the actinal surface of the plates is a lineal series of three short, subequal, skin-covered, papilliform spinelets, much smaller than the furrow series, slightly tapering at the end but obtuse, the direction of the series being usually in a straight line behind the furrow spine, at right angles to the furrow, but sometimes slightly oblique. Occasionally there is a fourth spine in this series, and sometimes the line of the series is slightly curved.

The actinal intermediate plates are small and form well-defined longitudinal series, two of which extend nearly to the end of the ray: about eight series may be counted on each side of the median interradial line. Each plate bears a group of from three to seven short, subequal, slightly tapering spinelets, covered with skin and imbedded at the base

and nearly to the tip in a thick fleshy mass. The tabulum or membranous base in which the spinelets are imbedded stands raised and erect out of the general actinal membrane. The groups are rather irregular in shape and the spinelets radiate slightly. The groups are distinctly spaced, having clear channels between.

The mouth-plates are rather large, and their armature consists of a marginal series of five robust, thickly skin-covered spines on each plate, which increase slightly in size as they proceed inward. The actinal surface of the united pair of mouth-plates is covered with smooth, shining membrane; and one or two short, robust, skin-covered spines stand near the outer end of each plate. The trend of the mouth-spines is slightly downward, and each mouth-angle has consequently rather a scoop-like appearance.

The madreporiform body is large and situated about midway between the centre and the margin, or rather nearer the former; several larger spine-groups are amongst those which surround it. The surface is flatly convex, the edge being bevelled. The striations are fine and much convoluted, and on the dissepiments are developed numerous low granuliform eminences.

The anal aperture is subcentral, and there is no modification in the spine-groups surrounding it.

No pedicellariæ are present.

Colour in alcohol, a warm light brownish shade.

Locality.—Station 313. Off Cape Virgins, eastern coast of South America, near the Atlantic entrance to the Strait of Magellan. January 20, 1876. Lat. 52° 20′ 0″ S., long. 67° 39′ 0″ W. Depth 55 fathoms. Sand. Bottom temperature, 47°·8 Fahr.; surface temperature, 48°·2 Fahr.

Remarks.—This species is in some respects more nearly related to *Cycethra electilis* than to the other forms. It is, however, at once distinguished by its generally inflated character, by the elongate rounded rays, by the obscure marginal plates, by the small and mass-like character of the spine-groups, and by the arrangement of the adambulacral armature.

Genus *Ganeria*, Gray.

Ganeria, Gray, Proc. Zool. Soc. Lond., 1847, Part xv. p. 83.

This genus appears to have a remarkably restricted area of distribution, confined to the neighbourhood of the Falkland Islands and the extreme southern point of America. Although morphologically isolated, there seems to be little doubt about its being correctly placed in the Asterinidæ; and I consider that its nearest ally is the genus *Cycethra*—a form as yet only known from the southern point of America and the neighbourhood of the Falkland Islands. *Cycethra*, however, extends to the Pacific side of the continent, whereas *Ganeria* has been taken only in the Atlantic.

Chorology of the Genus Ganeria.

a. Geographical distribution:—

Atlantic: One species between the parallels of 45° and 55° S.

Ganeria falklandica, from the Falkland Islands, and off Cape Virgins, near the Atlantic entrance to the Strait of Magellan.

β. Bathymetrical range: 55 fathoms.

γ. Nature of the Sea-bottom: Sand.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Ganeria falklandica . .	Atlantic.	55	Sand.

1. *Ganeria falklandica*, Gray (Pl. LX. figs. 1 and 2; Pl. LXII. figs. 6 and 7).

Ganeria falklandica, Gray, 1847, Proc. Zool. Soc. Lond., Part xv. p. 83.

Locality.—Station 313. Off Cape Virgins, east coast of South America, near the Atlantic entrance to the Strait of Magellan. January 20, 1876. Lat. 52° 20′ 0″ S., long. 67° 39′ 0″ W. Depth 55 fathoms. Sand. Bottom temperature, 47°·8 Fahr.; surface temperature, 48°·2 Fahr.

Remarks.—A considerable amount of variation occurs in the number of the spinelets on the abactinal plates, in the manner in which these are grouped, and in the extent and character of their membranous investment. In medium-sized examples there are as a rule comparatively few granuliform spinelets, on the outer part of the ray not more than two or three being near together; and the membrane only mounting their bases causes them to appear very short and conical. Furthermore, in small and medium-sized specimens the marginal plates have only a single vertical series of spinelets, excepting a few plates in the interbrachial arc, whereas in large examples the series is doubled; the disposition of the additional spinelets being subject, however, to considerable irregularity. In the examples collected by the Challenger the actinal intermediate plates usually bear one spine, and occasionally two or three—the latter number very rarely.

An interesting feature in this starfish, which appears to have escaped notice in the descriptions of Gray and Perrier,[1] is the presence of a more or less clearly defined broad medio-radial band, which is most distinct on the outer half of the ray, although in some

[1] Révis. Stell. Mus., p. 327 (*Archives de Zool. expér.*, 1876, t. v. p. 247).

examples it can scarcely be discerned at all. This is caused by a difference in the form of the abactinal plates, although the circumstance is scarcely apparent superficially owing to their membranous covering. The presence of this band suggests the character produced by the different form of the median and lateral series of abactinal plates in *Nepanthia*.

Subfamily Asterininæ, Sladen, 1888.

Genus *Patiria* (Gray), *emend.* Perrier.

Patiria, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 290.

Patiria, as constituted by Gray, was an ill-defined group, which included forms that cannot be separated by any essential character from *Asterina*. The genus was subsequently, and with great justice, limited by Perrier to one of the three sections made by Gray, and comprised only two species, those named by him *Patiria ocellifera* and *Patiria crassa*. This view of the genus is the only one which can be maintained. A third species has been added by the Challenger. That *Patiria* is very closely allied to *Asterina* there can be no doubt; and a young form which I have referred to the species described below indicates this affinity even more closely than the adult forms, and suggests the assumption that *Patiria* is probably immediately descended from an *Asterina*-like ancestor. As known at present the genus is confined to the southern hemisphere; but the locality of one of the original species is unknown.

Chorology of the Genus Patiria.

a. Geographical distribution:—

Atlantic: One species between the parallels of 30° and 40° S.
Patiria bellula, from Simon's Bay, Cape of Good Hope.

Indian Ocean: One species between the parallels of 10° and 50° S.
Patiria crassa from Western Australia.

β. Bathymetrical range: Shallow water.

γ. Nature of the sea-bottom: Not recorded.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Patiria bellula . . .	Atlantic.	Shallow water.	...
Patiria crassa . . .	Indian.	...	...
Patiria ocellifera . .	?	?	...

1. *Patiria bellula*, n. sp. (Pl. LXIII. figs. 1 and 2; Pl. LXIV. figs. 5 and 6).

Rays five. R = 49 mm.; r = 18 mm. Breadth of a ray between the fifth and sixth infero-marginal plates, 17 mm.; breadth near the tip, 7·5 mm.

Rays produced and rather long, semi-cylindrical, flattened actinally, rather broad at the base and tapering towards the extremity, which is blunt and obtusely rounded. Interbrachial arcs more or less rounded. Abactinal area of the disk convex. Actinal surface subplane or slightly convex.

The abactinal area is covered with comparatively large and more or less convex plates, amongst which smaller ones are interspersed. Numerous papulæ are present. The plates bear short, robust, subequal, papilliform spinelets which form groups. The plates on the outer part of the ray are larger and more distinct than elsewhere, and their shape is nearly circular. On the disk and the inner part of the ray they are smaller and more irregular, and there is a tendency for the plates, as indicated by the groups of spinelets, to assume here and there the crescentiform shape found in many species of *Asterina*. This character is more conspicuously shown in some examples than in others.

The marginal plates are very small, and on the outer part of the ray the two series appear to alternate. The supero-marginal plates are about thirty-two or thirty-three in number, counting from the median interradial line to the extremity. They are covered with a compact group of spinelets rather smaller than those on the abactinal plates generally, and the form of the plates as defined by these groups is nearly square.

The infero-marginal plates form the margin of the actinal surface, and are subequal in length to the plates of the superior series, but are not so high; they bear groups of similar spinelets.

The armature of the adambulacral plates consists of:—(1.) A furrow series of four spinelets, invested with membrane, partially united or webbed, forming a fan slightly obliquely placed, and high in the furrow. The spinelets are robust, cylindrical, obtusely tipped, and the two middle ones are usually longer than the others; sometimes only three spinelets are present. (2.) On the actinal surface of the plate is an obliquely placed fan of three or four (usually four) short, robust, papilliform spinelets, which are shorter and more robust than the furrow series, and radiate slightly apart.

In the actinal interradial areas five rows of intermediate plates may be counted; only two series extend to the end of the ray, the outer one becoming very small near the extremity; the third series extends about two-thirds of the length of the ray, and the remaining series are very short. All the intermediate plates bear groups of small, subequal, obtuse, papilliform spinelets, which are larger and more robust than those on the marginal plates, but rather smaller than the series of spinelets above described on the actinal surface of the adambulacral plates. The groups are more or less compact and well defined, each being distinctly spaced; about eight or nine spinelets are present

in the larger groups in the interradial area. In some examples the spinelets are less robust, and there are fully twice as many in a group.

The madreporiform body, which is small, is situated nearer the centre than midway between that point and the margin. It has a papillose rather than a striated appearance, in consequence of the frequent division of the intervening ridges. Several large plates with spinelets surround the margin.

Colour in alcohol, an ashy grey or greyish white.

Young Phase.—There is a small example from the same locality, which I have no hesitation in referring to the same species. Its measurements are R = 20 mm., $r = 7{\cdot}5$ mm. The outer part of the rays is occupied only by large diamond-shaped plates with a pore at the angles. At the base of the rays and on the disk small plates are intercalated, and these usually have a pore at each side; the larger plates are more elongate transversely, and there is occasionally a tendency to assume the crescent shape, which appears, however, to be mainly caused by the slight arching of the group of spinelets borne on the plates. This character produces more or less of the *Asterina* facies, and leads to the supposition that *Patiria* may perhaps be traced phylogenetically to an *Asterina* ancestor. The armature of the adambulacral plates and the spinulation of the actinal intermediate plates, as well as the character of both, accord exactly with the adult form described above.

Locality.—Simon's Bay, Cape of Good Hope. Shallow water.

Remarks.—This species resembles in many respects *Patiria crassa*, Gray, of which it is probably the South-African representative. *Patiria bellula* may be distinguished by the comparatively shorter rays, which are broader at the base and more tapering, and by the character of the adambulacral armature, which in *Patiria bellula* consists of two series composed of three or four spines in each, whereas in *Patiria crassa* there are at least three series, composed of five to seven spinelets in each. Furthermore in *Patiria bellula* these spinelets, as well as the spinelets on the actinal intermediate plates, are much more robust and altogether stronger in character than in *Patiria crassa*. This is specially noticeable in the case of the actinal intermediate plates.

Genus *Nepanthia*, Gray.

Nepanthia (*pars*), Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi., p. 287.
Asterina (subgenus *Nepanthia*), Perrier, Révis. Stell. Mus., 1876, p. 320 (Archives de Zool. expér., t. v. p. 240).

Gray included two species in his genus *Nepanthia*, one of which is a *Chætaster*. This was pointed out by Perrier, who thus limited the genus, and added at the same time two new species founded on specimens preserved in the British Museum. Perrier,[1] at

[1] Révis. Stell. Mus., pp. 295, 320 (*Archives de Zool. expér.*, t. v. pp. 215, 240).

the same time, ranked *Nepanthia* only as a subgenus under *Asterina*. In my estimation, however, the structure and arrangement of the skeletal elements, the general form as a whole, the tegumentary appendages, and the character of the armature of the adambulacral plates, warrant the retention of *Nepanthia* as an independent genus.

Chorology of the Genus Nepanthia.

α. Geographical distribution:—

Eastern Archipelago: Two species between the parallels of 20° N. and 20° S. **Nepanthia brevis*, in Torres Strait. **Nepanthia maculata* in the Arafura Sea, and from Migupou (*fide* Gray).

β. Bathymetrical range: The two species of which the conditions of the locality are known are confined to shallow water, the greatest depth recorded being 28 fathoms.

γ. Nature of the Sea-bottom: Nepanthia brevis is found on Shell sand and Coral mud, and *Nepanthia maculata* on Green mud.

The locality and conditions of habitat of *Nepanthia belcheri* are unknown; it is therefore not included in the foregoing list.

The species collected by the Challenger are marked with an asterisk.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Nepanthia belcheri . .	?	?	?
Nepanthia brevis . . .	Eastern Archipelago.	8	Shell sand, Coral mud.
Nepanthia maculata . .	Eastern Archipelago.	28	Green mud.

1. *Nepanthia brevis*, Perrier (Pl. LXIII. figs. 3–5).

Asterina (*Nepanthia*) *brevis*, Perrier, 1876, Révis. Stell. Mus., p. 321 (Archives de Zool expér., t. v. p. 241).

Locality.—Station 186. North of Cape York, Torres Strait. September 8, 1874. Lat. 10° 30′ 0″ S., long. 142° 18′ 0″ E. Depth 8 fathoms. Coral mud. Surface temperature 77°·2 Fahr.

Remarks.—Only a single example of this interesting but well-marked form was dredged by the Challenger. I have given drawings of it, as the species is little known.

2. *Nepanthia maculata*, Gray (Pl. LXIV. figs. 1–4).

Nepanthia maculata, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 287.
Chætaster (?) *maculatus*, Müller and Troschel, 1842, System der Asteriden, p. 28.
? *Chætaster cylindratus*, Möbius, 1859, Neue Seesterne des Hamburger and Kieler Museums, p. 1, Taf. 1, figs. 3 and 4 (Abhandl. a. d. Gebiete Naturw. hrsg. v. d. naturwiss. Verein, Hamburg, Bd. iv. Abth. 2, 1860).
Asterina (*Nepanthia*) *maculata*, Perrier, 1876, Révis. Stell. Mus., p. 322 (Archives de Zool. expér., t. v., p. 242).

Locality.—Station 188. In the Arafura Sea. September 10, 1874. Lat. 9° 59′ 0″ S., long. 139° 42′ 0″ E. Depth 28 fathoms. Green mud. Surface temperature 78°·5 Fahr.

Remarks.—Only a single example of this handsome species was procured by the Challenger. I have given drawings, as the form is little known, and the descriptions published are rather vague in some respects.

With regard to the adambulacral armature it may be mentioned that I believe the drawing given on Pl. LXIV. fig. 4, represents the natural posture of the spinelets during life. In a few favourable instances in the specimen under notice they may be seen thus disposed, but usually when preserved in spirit and in the dry condition the spinelets on the actinal surface of the adambulacral plates are drawn together and form a compact group, which closely resembles in form and character the groups of fine spinelets on the adjacent intermediate plates.

I have examined the type of Möbius' *Chætaster cylindratus* in the Hamburg Museum, and, though I have not compared it side by side with Gray's example, I feel little hesitation in regarding it as the same species.

Genus *Asterina*, Nardo.

Asterina, Nardo, De Asteriis, Oken's Isis, 1834, p. 716.
Asteriscus (*pars*), Müller and Troschel, Monatsber. d. k. preuss. Akad. d. Wiss., Berlin, 1840 (April), p. 104.

This well-characterised genus has been subjected to comparatively few changes at the hands of classifiers. Perrier[1] pointed out that there is no sufficient reason for discarding the name given by Nardo in favour of *Asteriscus* proposed by Müller and Troschel on the ground that the word in question was employed by Llhuyd and Linck. *Asteriscus* was not used in the sense of a generic name anterior to 1840.

Notwithstanding the considerable number of species, the amount of structural variation within the limits of the genus which they represent is comparatively small.

The distribution of the genus is almost cosmopolitan, but confined to the tropical and temperate seas.

[1] Révis. Stell. Mus., p. 294 (*Archives de Zool. expér.*, 1876, t. v., p. 214).

Synopsis of the Species of Asterina, *herein mentioned.*

A. Actinal intermediate plates with few spines (two to five), arranged in single series.
  a. Actinal intermediate plates with one spine only on the inner part of the interradial area.
    a. Actinal intermediate plates with one spine on the outer plates. Adambulacral plates with one spine on the actinal surface.
      α. Actinal intermediate plates with one spine on all plates. Abactinal plates with granules arranged in semicircles. Five rays. Spines on actinal intermediate plates short and conical . . . . . *regularis.*
      β. Actinal intermediate plates on the inner part of the interradial area devoid of spines. Abactinal plates with granules not arranged in semicircles . . . . *exigua.*
    b. Actinal intermediate plates with two spines on the outer plates. Adambulacral plates with two spines on the actinal surface. Abactinal plates well-spinulated or granulate. Six rays . . *gunnii.*
  b. Actinal intermediate plates with two to five spines on each plate.
    a. Adambulacral plates with two or three spines on the actinal surface. Abactinal plates well spinulated.
      α. Actinal intermediate plates with more than two spines. Adambulacral plates with four or five spinelets in the furrow series. Actinal intermediate plates with five spines in line, pointed . . . . . *pectinifera.*
    b. Adambulacral plates with more than three spines on the actinal surface. Abactinal plates almost naked, spinelets simply marginal and inconspicuous.
      α. Actinal intermediate plates with three or four long delicate spines, united by membrane, not regularly in line. Adambulacral plates with four or five spines on the furrow margin and three or four on the actinal surface . *folium.*
      β. Actinal intermediate plates with two to four short, small, conical spinelets, not united. Adambulacral plates with five to seven spines on the furrow series and four or five on the actinal surface . . . . . *cepheus.*
B. Actinal intermediate plates with numerous (eight to sixteen) spines, forming a double or triple line . . . . . *penicillaris.*

Chorology of the Genus Asterina.

a. Geographical distribution:—

Atlantic: Eleven species between the parallels of 60° N. and 40° S.

Asterina gibbosa, off the European and North African coasts, and in the Mediterranean. *Asterina gibbosa* is also reputed to extend into the Indian Ocean and Eastern Archipelago, but the occurrence of this species out of the Atlantic needs verification,

Asterina cepheus being probably the form in question. *Asterina squamata* and *Asterina marginata*, off Senegal, the latter extending across the Atlantic to Brazil. *Asterina minuta* (Gray), *Asterina lymani*, *Asterina pilosa*, and **Asterina folium*, from the West Indian area, the last-mentioned also off the coast of Florida (*fide* Alexander Agassiz). *Asterina granifera*, *Asterina coccinea*, *Asterina gunnii*, and **Asterina exigua*, from the Cape of Good Hope; *Asterina coccinea* extending into the Indian Ocean to Mozambique, *Asterina gunnii* extending to Australia and Tasmania, and *Asterina exigua* extending through the Indian and Southern Oceans into the Eastern Archipelago and Pacific.

Indian and Southern Oceans: Seven (or eight ?) species between the parallels of 30° N. and 40° S.

**Asterina cepheus*, **Asterina penicillaris*, and *Asterina wega*, from the Red Sea; *Asterina cepheus* is also found off Zanzibar and Mozambique, and extends into the Eastern Archipelago and Pacific; *Asterina penicillaris* is also found off Port Natal, and extends into the Eastern Archipelago and Pacific; *Asterina wega* is also found off Mauritius. *Asterina gibbosa* is reputed to occur in the Red Sea, and at Mauritius and Madagascar, and to extend into the Eastern Archipelago, but *Asterina cepheus* is probably the species intended. *Asterina coccinea* and *Asterina coronata*, off Mozambique, the former extending to the Cape of Good Hope, and the latter into the Eastern Archipelago. As to the specific distinction of *Asterina coronata* from *Asterina cepheus* I am somewhat doubtful. *Asterina fimbriata*, off the Island of Bourbon. **Asterina exigua*, from Natal, Mauritius, Madagascar, St Paul Island, extending to the Cape of Good Hope, and passing eastward into the Eastern Archipelago and Pacific.

Eastern Archipelago: Four (or five ?) species between the parallels of 20° N. and 20° S.

**Asterina cepheus*, **Asterina exiguus*, and **Asterina penicillaris* from Java; *Asterina cepheus* and *Asterina exigua* are also found off the Philippines and extend into the Indian Ocean and Pacific, the latter occurring at the Cape of Good Hope. *Asterina exigua* and *Asterina penicillaris* are also found off the Moluccas, and the latter at Flores, and extending into the Pacific and Indian Oceans. *Asterina coronata* (the specific distinctness of which from *Asterina cepheus*

seems to me rather doubtful) is from Amboina and the Moluccas and extending into the Indian Ocean. *Asterina gibbosa* is reputed to occur in the Eastern Archipelago, but probably *Asterina cepheus* is the species intended.

Pacific: Fifteen or sixteen species between the parallels of 60° N. and 50° S. **Asterina pectinifera* and **Asterina penicillaris*, from Japan. *Asterina calcar*, **Asterina exigua*, **Asterina gunnii*, **Asterina regularis*, and **Asterina penicillaris*, from Australia. *Asterina exigua* and *Asterina penicillaris* extend into the Eastern Archipelago and Indian Ocean, the former reaching the Atlantic at the Cape of Good Hope. *Asterina gunnii* is also found off Tasmania and extends to the Cape of Good Hope. *Asterina regularis* is also found off New Zealand. *Asterina novæ-zealandiæ* off New Zealand. *Asterina cepheus* off New Caledonia, and extending into the Eastern Archipelago and Indian Ocean. *Asterina calcarata*, *Asterina gayi*, *Asterina pusilla*, and *Asterina chilensis*, off the coast of Chili, the last-mentioned also off Peru. *Asterina obtusa* and *Asterina modesta* from Panama, the latter also from the Pearl Islands. *Asterina granulosa* from the Sandwich Islands. *Asterina miniata* from California and extending as far northward as the Island of Sitka.

β. *Bathymetrical range:* Shallow water; all the species so far as known to me are confined to the Littoral zone. The greatest depth is attained by *Asterina lymani*, which is found in 120 to 140 fathoms.

γ. *Nature of the Sea-bottom:* Recorded in very few instances. Probably always more or less hard. Usually rocks and stones.

Chorological Synopsis of the Species herein mentioned.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Asterina cepheus .	Indian, Eastern Archipelago, and Pacific.	10	Coral reefs.
Asterina exigua . .	Atlantic,[1] Indian, Eastern Archipelago, Pacific.	10	Coral reefs, &c.
Asterina folium . .	Atlantic.	...	...
Asterina gunnii . .	Pacific, Atlantic.[1]	...	...
Asterina pectinifera .	Pacific.	5 to 25	...
Asterina penicillaris .	Indian, Eastern Archipelago, and Pacific.	8 to 50	...
Asterina regularis .	Pacific.	10	...

[1] At the Cape of Good Hope.

The locality of the following three species is unknown, and their names are not included in the foregoing list :—

Asterina setacea (Val.), Perrier. | *Asterina stellaris*, Perrier. | *Asterina trochiscus* (Retz.), Perrier.

Asterina trochiscus is associated with the vague statement "Habitat in mari indico;" and the species itself appears to me to be more or less doubtful.

The species collected by the Challenger are indicated in the foregoing list with an asterisk.

1. *Asterina regularis*, Verrill.

Asterina gunnii, var., Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 290.
Asteriscus australis (*pars*), Müller and Troschel, 1842, System der Asteriden, p. 43.
Asterina (*Asteriscus*) *regularis*, Verrill, 1871 (1867), Trans. Conn. Acad. Arts and Sci., vol. i. part 2, p. 250.
Asterina cabbalistica, Lütken, 1871, Videnskab. Medd. naturh. Foren. i Kjøbenhavn, p. 242, pl. iv. fig. 1.
Asterina regularis, Hutton, 1872, Cat. Echin. New Zealand, p. 9.

Locality.—Queen Charlotte Sound, New Zealand. June 27, 1874. Depth 10 fathoms.

2. *Asterina exigua* (Lamarck), Perrier.

Asterias exigua, Lamarck, 1816, Hist. nat. anim. s. vert., t. ii. p. 554.
Asterias minuta, de Blainville, 1834, Manuel d'Actinologie, p. 238.
Asterina Kraussii, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 289.
Asteriscus pentagonus, Müller and Troschel, 1842, System der Asteriden, p. 42.
Asteriscus Kraussii, Müller and Troschel, 1842, System der Asteriden, p. 42.
Asterina pentagona, v. Martens, 1866, Archiv f. Naturg., Jahrg. xxxii. Bd. i. p. 74.
Asterina exigua, Perrier, 1876, Révis. Stell. Mus., p. 302 (Archives de Zool. expér., t. v. p. 222).

Localities.—Simon's Bay, Cape of Good Hope. Shallow water.
Sea Point, near Cape Town.
Station 212, off Samboangan, Philippine group. Depth 10 fathoms. On the reefs.
Port Jackson. Depth 6 fathoms.

3. *Asterina gunnii*, Gray.

Asterias calcar, var. *b*, Lamarck, 1816, Hist. nat. anim. s. vert., t. ii. p. 557.
Asterina gunnii, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 289.
Asteriscus australis (*pars*), Müller and Troschel, 1842, System der Asteriden, p. 243.
Asteriscus Diesingi, Müller and Troschel, 1842, System der Asteriden, p. 43.
Asteriscus calcar, Dujardin and Hupé, 1862, Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 377.
Asteriscus exiguus, Perrier, 1869, Ann. Sci. Nat., 5e Série, t. xii. p. 292.

Locality.—Port Jackson. Depth 7 fathoms.

4. *Asterina pectinifera* (Müller and Troschel), v. Martens.

Asteriscus pectinifer, Müller and Troschel, 1842, System der Asteriden, p. 40.
Asterina pectinifera, v. Martens, 1865, Archiv f. Naturgesch., Jahrg. xxxi. Bd. i. p. 352.

Locality.—Yokohama. Depth 5 to 25 fathoms.

5. *Asterina folium* (Lütken), Agassiz.

Asteriscus folium, Lütken, 1860, Videnskab. Medd. naturh. Foren. i Kjøbenhavn for 1859, p. 60.
Asterina folium, A. Agassiz, 1877, Mem. Mus. Comp. Zoöl. Harvard, vol. v. No. I. p. 106.

Locality.—Bermuda. Depth and conditions not recorded.

Remarks.—A single example was obtained at Bermuda, which I refer with some hesitation to Lütken's *Asterina folium*. The marginal contour appears to be more pentagonal, the interbrachial arcs being less indented; and the abactinal plates seem to me to be relatively larger and more convex in form.

Asterina folium, Lütken, is placed by Perrier[1] as a synonym under *Asterina minuta*, Gray. The example under notice differs altogether from the type specimens of *Asterina minuta*, Gray, which are preserved in spirit in the British Museum, and still bear their original label in Gray's handwriting. These examples do not appear to have been seen by Perrier. Under these circumstances I regard the *Asterina folium* of Lütken and the *Asterina minuta* of Gray as distinct species.

6. *Asterina cepheus* (Müller and Troschel), v. Martens.

Asteriscus cepheus, Müller and Troschel, 1842, System der Asteriden, p. 41.
Asterina Burtonii, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 289.
Asterina cepheus, v. Martens, 1866, Archiv f. Naturgesch., Jahrg. xxxii. Bd. i. p. 85.

Locality.—Samboangan, Philippine group. Depth 10 fathoms, on the reefs.
A single example in a bad state of preservation.

7. *Asterina penicillaris* (Lamarck), v. Martens.

Asterias penicillaris, Lamarck, 1816, Hist. nat. anim. s. vert., t. ii. p. 555.
Asteriscus penicillaris, Müller and Troschel, 1842, System der Asteriden, p. 42.
Asterina penicillaris, v. Martens, 1866, Archiv f. Naturgesch., Jahrg. xxxii. Bd. i. p. 74.

Locality.—Kobé, Japan. Depth 8 to 50 fathoms.

[1] Révis. Stell. Mus., p. 309 (*Archives de Zool. éxper.*, 1876, t. v. p. 229).

Subfamily Palmipedinæ, Sladen, 1888.

Genus *Palmipes*, Linck.

Palmipes, Linck, De Stellis marinis, 1733, p. 29.
Anseropoda, Nardo, De Asteriis, Oken's Isis, 1834, p. 716.
Asteriscus (*pars*), Müller and Troschel, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, 1840, p. 104.

This remarkable and sharply defined genus appears to be comparatively local in its occurrence, although the recorded localities are widely distributed. The small number of species indicates a very limited range of morphological variation, which is all the more remarkable when the isolated character of the structure of the genus is taken into consideration.

The structural peculiarities of *Palmipes* have led me to place the genus in a distinct subfamily, in which I have included the allied genus *Stegnaster*. With these I am inclined to think that *Tremaster*, Verrill, should also be associated; but as I have not had an opportunity of examining the structure of that form, and as no account of its details has been published, nor any suggestion as to the affinities of this abnormal genus thrown out by its author, I feel at present some uncertainty as to whether *Tremaster* should be classed with the Palmipedinæ or Asterininæ.

Chorology of the Genus Palmipes.

α. *Geographical distribution*:—

Atlantic: One species between the parallels of 30° and 65° N.
Palmipes membranaceus, off the British Islands, in the English Channel, off the coast of France, and in the Mediterranean and the Adriatic.

Indian Ocean: One species between the parallels of 10° and 25° N.
Palmipes rosaceus, from the Bay of Bengal (Berlin Mus.). This form also occurs off Japan (*fide* Gray).

Pacific: Two species between the parallels of 40° N. and 5° S.
Palmipes diaphanus, from North of Admiralty Island; and *Palmipes rosaceus*, from Japan, the latter extending to the Bay of Bengal.

β. *Bathymetrical range*: 20 to 150 fathoms.
Greatest range of one species: *Palmipes membranaceus*, 20 to 100 fathoms.

γ. *Nature of the Sea-bottom*: *Palmipes diaphanus* lives on Coral mud.
The nature of the ground inhabited by *Palmipes membranaceus* and *Palmipes rosaceus* is not recorded. The want of information in the case of the comparatively common form, *Palmipes membranaceus*, is surprising.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Palmipes diaphanus . .	Pacific.	150	Coral mud.
Palmipes membranaceus .	Atlantic.	20 to 100	...
Palmipes rosaceus . .	Pacific and Indian.	...	...

1. *Palmipes membranaceus*, Linck.

Stella cartilaginea, Aldrovandus, 1602, De Animalibus Insectis, p. 743.
Palmipes membranaceus, Linck, 1733, De Stellis marinis, p. 29, pl. i. No. 2.
Asterias placenta, Pennant, 1777, British Zoology, vol. iv. p. 62, pl. xxxi. fig. 59A.
Asterias membranacea, Retzius, 1783, K. Vet.-Akad. Nya Handl. Bd. iv. p. 238.
Asterias cartilaginea, Fleming, 1828, Hist. Brit. Animals, p. 485.
Anseropoda membranacea, Nardo, 1834, De Asteriis, Oken's Isis, p. 716.
Asteriscus membranacea, Müller and Troschel, 1840, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, p. 104.
Asteriscus palmipes, Müller and Troschel, 1842, System der Asteriden, p. 39.
Palmipes placenta, Norman, 1865, Ann. and Mag. Nat. Hist., ser. 3, vol. xv. p. 120.

Locality.—"Porcupine" Expedition:
The Minch, 1869. Exact locality and conditions not recorded.

2. *Palmipes diaphanus*, n. sp.

Rays five. R = 42 mm.; $r = 25$ mm. The minor radius is thus in the proportion of about 60 per cent.

Rays comparatively well produced for the genus, sublanceolate or leaf-like in outline, the curvature of the contour having a graceful convexity laterally, and the extremity distinctly pointed. The body, which is extremely delicate and thin, is semi-transparent. An abruptly-rising rounded ridge proceeds along each radial line.

The plates of the abactinal surface bear from three to five isolated tufts of small spinelets. Those in the median region of the disk bear four or five—three placed near the free margin (a larger one with a small one on each side), and one or two side by side, behind these. Beyond the central region and along the rays there are generally only three present, which are placed near the free margin. The larger tufts are composed of seven or eight short delicate spinelets, and the smaller tufts of five or six rather shorter ones. All the spinelets are microscopic and embryonic in character.

The armature of the adambulacral plates consists of (1.) a series of six delicate elongate spinelets on the furrow margin; and (2.) on the actinal surface of the plate a series of

four similar spinelets, one of which is subequal to the furrow series, the others smaller; near the mouth there may be six spinelets in this series, and on the outer part of the ray there are only three. This series may be disposed in an oblique line, but is usually in an arc.

The mouth-plates are comparatively large, and their armature consists of a marginal series of about ten rather robust, cylindrical, obtuse spinelets, and a secondary or superficial series of about the same number of more delicate and tapering spinelets, similar to those on the adambulacral plates, arranged in a compact arc on the actinal surface of each plate. A few additional smaller spinelets may also be present.

The actinal plates bear a series or comb of four small spinelets, one of the median ones being a little longer than the others, and all radiate slightly apart. Near the mouth there may be five spinelets in a comb; also one or two very small spinelets on each side, isolated from the comb. The plates, which form regular transverse series, become very small as they approach the margin, and the small combs of spinelets are very closely placed there, one comb almost overlapping the next outermost in its own column or series.

The marginal plates, which are very small but distinct and isolated, are somewhat in the form of the blade of an old battle-axe, and they bear on their curved free margin a double comb of about sixteen small subequal spinelets. These plates alternate with the columns of abactinal plates; and there is at the base of each of the plates just described a second small plate with a comb of spinelets, which I regard as the representative of the supero-marginal plate.

The papular orifices are large and spiracle-like, margined by seven or more plates, each of which bears a small comb of rather elongate spinelets directed over the opening. The orifices, which are disposed in a single line on each side of the median radial line, are very few in number and irregularly spaced. There do not appear to be more than five to eight on each side of the radial ridge, and these may be arranged five or six near together near the middle of the radial line and tolerably equally spaced, and then one or two nearer the centre or nearer the extremity; or there may be only two or three near together. The occurrence of orifices on one side of the median ridge does not correspond with the occurrence of orifices on the other side.

Colour in alcohol, pellucid white.

Locality.—Station 219. Off D'Entrecasteaux Reef, North of Admiralty Island. March 10, 1875. Lat. 1° 54′ 0″ S., long. 146° 39′ 40″ E. Depth 150 fathoms. Coral mud. Surface temperature 84°·0 Fahr.

Remarks.—This species is a true *Palmipes*, but differs so essentially from either *Palmipes membranaceus* or *Palmipes rosaceus* that no comparison is necessary. It is an interesting addition to the small number of species of this singular genus. Unfortunately the specimen collected by the Challenger is only a fragment. The whole starfish must be an extremely elegant form, remarkable for its delicacy and transparency.

Order CRYPTOZONIA, Sladen, 1888.

Family Linckiidæ, Perrier, 1875, *emend.*

The family Linckiidæ, if the genera *Chætaster* and *Metrodira* be excepted, is one which presents great solidarity in its morphological facies. The two genera just named differ, however, so greatly in their general character from the other forms included in the family that I have placed them in distinct subfamilies. The plan of their structure is more in consonance with that of the Linckiidæ as a whole than with that of any other family, but the details of their structure place them as very divergent members of the family, and warrant, in my estimation, the course I have taken for bringing into prominence their aberrant and transitional character.

Viguier[1] first referred *Chætaster* to this family, but he removed *Fromia*, *Ferdina*, and *Metrodira* to his family Goniasteridæ. This latter step I am unable to approve, and I agree with Perrier in ranking these genera under the Linckiidæ.

It has seemed to me useful to reinstate some of the genera recognised by Gray, which have been absorbed by subsequent writers on what appear to me insufficient grounds.

Synopsis of the Genera included in the Family Linckiidæ.

A. Abactinal plates with internal supplementary plates. Abactinal plates with paxilliform tabula . . . . . Chætasterinæ.
  a. A single genus . . . . . *Chætaster.*
B. Abactinal plates devoid of internal supplementary plates; not forming paxilliform tabula.
  a. Abactinal and marginal plates granulose and not bearing spines . . Linckiinæ.
    a. Devoid of superambulacral plates.
      α. Adambulacral armature in two or more series. Papulæ on the actinal surface. Marginal plates larger than the others. Abactinal plates comparatively small . . . *Fromia.*
      β. Adambulacral armature in a single series. No papulæ on actinal surface. Marginal plates not larger than the others. Abactinal plates large and more or less convex . *Ferdina.*
    b. With superambulacral plates.
      α. Abactinal plates in regular longitudinal series. Adambulacral armature in two unequal series; the outermost large and spiniform. Papulæ on the actinal surface.
        i. Abactinal and marginal plates granulose or bearing squamiform papillæ.
          1. Papular areas not confluent laterally. Madreporiform body simple . . . . . *Ophidiaster.*

[1] *Archives de Zool. expér.*, 1878, t. vii. p. 147.

2. Papular areas confluent laterally. Madreporiform body large and compound . . . *Pharia.*

ii. Abactinal and marginal plates (in fact the whole test) covered with a thick membranous investment . . *Leiaster.*

β. Abactinal plates not forming regular longitudinal series.

i. Adambulacral armature granuliform, two or three series. No papulæ on the actinal surface. Abactinal plates comparatively small.

1. Rays more or less cylindrical. Papulæ in areas irregularly distributed amongst the abactinal plates . . . . . *Linckia.*

2. Rays trigonal. Papulæ in one or two continuous uninterrupted rows on each side of the ray . . . . . *Phataria.*

ii. Adambulacral armature papilliform or spiniform, subprismatic, usually in three series. Abactinal plates comparatively large.

1. Rays rounded. Papulæ on the actinal surface. Papulæ in areas . . . . *Nardoa.*

2. Body pyramidal, rays triangular in section. No papulæ on the actinal surface. Papulæ single, isolated . . . . . *Narcissia.*

b. Abactinal and marginal plates covered with membrane, the former and occasionally the latter bearing isolated skin-covered spinelets . . METRODIRINÆ.

a. A single genus . . . . . *Metrodira.*

Subfamily CHÆTASTERINÆ, Sladen, 1888.

Genus *Chætaster*, Müller and Troschel.

Chætaster, Müller and Troschel, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, April 1840, p. 103.
? *Astropus* (subgen.), Gray, Ann. and Mag. Nat. Hist., Nov. 1840, vol. vi. p. 182.
Nepanthia (*pars*), Gray, Ann. and Mag. Nat. Hist., Dec. 1840, vol. vi. p. 287.

This singular genus was originally ranked with the Astropectinidæ, but was removed by Viguier[1] in 1878 to the Linckiidæ. The justice of this step has recently been recognised by Perrier.[2] I fully concur in this, although I regard *Chætaster* as a very abnormal member of the family, and have placed it in a distinct subfamily.

Chorology of the Genus Chætaster.

a. Geographical distribution :—

ATLANTIC : Two species between the parallels of 10° and 40° N.

Chætaster longipes, from the Mediterranean, and off the Azores and Bermuda. *Chætaster nodosus*, from Guadeloupe.

[1] *Archives de Zool. expér.*, 1878, t. vii. p. 147.
[2] *Nouv. Archives Mus. Hist. Nat.*, 2e Serié, 1884, t. vi. p. 164.

β. *Bathymetrical range:* 30 to 450 fathoms.

γ. *Nature of the Sea-bottom:* *Chætaster longipes* on coral reefs and on volcanic mud.

The localities of *Chætaster hermanni*, Müller and Troschel, and *Chætaster troschelii* (Valenciennes MS.), Müller and Troschel, are unknown. The type of the latter species is lost, and I consider that the name should be discarded. I am in great doubt as to whether either of these forms could be referred to the genus *Chætaster* established on the basis of *Chætaster longipes*.

Chorological Synopsis of the Species herein mentioned.

	Ocean.	Range of Fathoms.	Nature of the Sea-bottom.
Chætaster longipes . .	Atlantic.	30 to 450	Coral; Volcanic mud.

1. *Chætaster longipes* (Retzius), Sars.

Asterias longipes, Retzius, 1805, Diss. sist. spec. cog. Asteriarum, p. 20.
Asterias subulata, Lamarck, 1816, Hist. nat. anim. s. vert., t. ii. p. 568.
Chætaster subulata, Müller and Troschel, 1840 (April), Monatsber. d. k. preuss. Akad. d. Wiss. Berlin p. 103; System der Asteriden, 1842, p. 27.
? *Astropecten* (*Astropus*) *longipes*, Gray, 1840 (Nov.), Ann. and Mag. Nat. Hist., vol. vi. p. 182 Synop. Spec. Starf. Brit. Mus., 1866, p. 4.
Nepanthia tessellata, Gray, 1840 (Dec.), Ann. and Mag. Nat. Hist., vol. vi. p. 287; Synop. Spec Starf. Brit. Mus., 1866, p. 15.
Chætaster longipes, Sars, 1857, Bidrag til Kundskaben om Middelhavets Littoral-Fauna, p. 107.

Localities.—Station 75. Between the Islands of Fayal and San Jorge, Azores. July 2, 1873. Lat. 38° 38′ 0″ N., long. 28° 28′ 30″ W. Depth 450 fathoms. Volcanic mud. Surface temperature 70°·0 Fahr.

Station 36. Off Bermuda. April 22, 1873. Lat. 32° 7′ 25″ N., long. 65° 4′ 0″ W. Depth 30 fathoms. Coral. Surface temperature 67°·5 Fahr.

"Porcupine" Expedition:

A single example. Locality and depth not recorded.

Remarks.—All the examples collected at the above-mentioned stations are of smaller habit than that usual in full-grown specimens from the Mediterranean. A number of the examples from Station 36 have here and there tubercular enlargements of the paxillæ, which recall the knobs present in *Chætaster nodosus*, Perrier, and appear to me to be of the same character. In *Chætaster nodosus* the knobs are very numerous, and present a conspicuous facies, which led me to regard M. Perrier's example as a well-marked form when I had the privilege of examining it in his laboratory in Paris.

There is an example of this species in the collection made during the "Porcupine" Expedition, but no record of the locality or depth is given. It is perhaps the starfish referred to by Sir Wyville Thomson[1] as "a fine Scytaster, probably identical with the *Asterias canariensis* of d'Orbigny." This erroneous view of the identity of the *Asterias longipes* of Retzius with the *Asterias canariensis* of d'Orbigny had been previously suggested by Lütken,[2] and the form was ranked by him as a *Scytaster*. There is no other example belonging to this family in the "Porcupine" collection, received by me.

The starfish which bears Gray's name of *Astropecten longipes* in the British Museum is a *Chætaster longipes;* and there appears to be little doubt that this is the form named by Gray, notwithstanding the contradictory character of some of the statements in his short diagnosis of the species.

Subfamily Linckiinæ, Sladen, 1888.

Genus *Fromia*, Gray.

Linckia (*pars*), Müller and Troschel, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, April 1840, p. 103.
Fromia, Gray, Ann. and Mag. Nat. Hist., 1840 (December), vol. vi. p. 286.
Scytaster (*pars*), Müller and Troschel, System der Asteriden, 1842, p. 34.

This genus was removed from the Linckiidæ by Viguier,[3] and placed in his family Goniasteridæ; I prefer, however, to revert to Perrier's classification of the form amongst the Linckiidæ. The genus is essentially an inhabitant of the tropics, and the type species may be regarded as a common form.

Chorology of the Genus Fromia.

a. Geographical distribution:—

Indian Ocean: Three species between the parallels of 30° N. and 30° S.
Fromia milleporella, from the Red Sea, Mauritius, Madagascar, Ceylon, and extending into the Eastern Archipelago and Pacific. *Fromia tumida*, from Ceylon. *Fromia indica*, exact locality unknown; recorded as "mers de l'Inde."

Eastern Archipelago: Two species between the parallels of 10° N. and 10° S.
Fromia milleporella, from the Moluccas and Amboina (*fide* de Loriol), extends into the Indian Ocean and also into the Pacific. *Fromia monilis*, from Amboina.

[1] Depths of the Sea, p. 171.
[2] *Videnskab. Medd. naturh. Foren. i Kjøbenhavn*, for 1864, p. 169.
[3] *Archives de Zool. expér.*, 1878, t. vii. p. 166.

PACIFIC: Three species between the parallels of 40° (?) N. and 30° S. *Fromia japonica*, from Japan. *Fromia balansæ* and *Fromia milleporella*, from New Caledonia, the latter extending into the Eastern Archipelago and Indian Ocean.

β. *Bathymetrical range:* All the known species are probably confined to shallow water.

γ. *Nature of the Sea-bottom:* Recorded in few cases. *Fromia milleporella* on Coral reefs.

Chorological Synopsis of the Species herein mentioned.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Fromia milleporella . .	Indian, Eastern Archipelago, and Pacific.	Shallow water.	Coral reefs.

1. *Fromia milleporella* (Lamarck), Gray.

Asterias milleporella, Lamarck, 1816, Hist. nat. anim. s. vert., t. ii. p. 564.
Linckia milleporella, Müller and Troschel, 1840 (April), Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, p. 103.
Fromia milleporella, Gray, 1840 (December), Ann. and Mag. Nat. Hist., vol. vi. p. 286.
Scytaster pistorius, Müller and Troschel, 1842, System der Asteriden, p. 35.
Scytaster milleporellus, Michelin, 1845, Faune de l'Île Maurice, Mag. de Zool., p. 22.
Linckia (*Scytaster*) *milleporella*, v. Martens, 1866, Archiv f. Naturgesch., Jahrg. xxxii., Bd. i. p. 69.
Linckia pistoria, v. Martens, 1869, v. d. Decken's Reisen in Ost-Africa, Zool., p. 130.

Locality.—Kandavu, Fiji Islands. On the reefs.

Remarks.—These examples, which are rather small, are short in the ray, and noticeable for having a number of the abactinal plates near the end of the ray convex and subtubercular, and bearing two or three granules larger and more prominent than the rest.

Genus *Ophidiaster*, Agassiz.

Ophidiaster, Agassiz, Prod. Monogr. d. Radiaires, Mém. Soc. Sci. Nat. Neuchatel, 1835, t. i., p. 191.
Dactylosaster, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 283.
Tamaria, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 283.
? *Cistina*, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 283.
Hacelia (subgen.), Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 284.
Linckia (*pars*), v. Martens, Archiv f. Naturgesch., 1865, Jahrg. xxxi., Bd. i. p. 351.

This genus, as limited by Perrier, is a well-defined group, distributed over a wide area. *Ophidiaster* occurs chiefly in tropical seas, and does not extend beyond the warm temperate regions; it is a shallow water form, usually frequenting the Littoral zone.

Chorology of the Genus Ophidiaster.

a. Geographical distribution:—

Atlantic: Five species between the parallels of 10° and 45° N.

**Ophidiaster attenuatus, Ophidiaster lessonæ,* and **Ophidiaster ophidianus,* from the Mediterranean, the last named extending to the Canary Islands and Cape Verde Islands. *Ophidiaster floridæ,* from Florida. *Ophidiaster guildingii,* from St Thomas, Antilles.

Indian Ocean: Six species between the parallels of 30° N. and 30° S.

Ophidiaster hemprichii from the Red Sea. *Ophidiaster purpureus,* from Mauritius and the Seychelle Islands. *Ophidiaster duncani, Ophidiaster perrieri, Ophidiaster robillardi,* and **Ophidiaster cylindricus,* from Mauritius, the last named extending into the Eastern Archipelago and Pacific.

Eastern Archipelago: Six species between the parallels of 20° N. and 20° S.

**Ophidiaster cylindricus,* from the Moluccas, and extending into the Indian Ocean and Pacific. *Ophidiaster fuscus,* from Migupou. *Ophidiaster pustulata* and *Ophidiaster pusillus,* from Flores and Amboina, the latter also from the Philippine Islands and extending into the Pacific. **Ophidiaster tuberifer* and **Ophidiaster helicostichus,* from Torres Strait.

Pacific: Seven species between the parallels of 30° N. and 40° S.

Ophidiaster agassizii, from Juan Fernandez. *Ophidiaster gracilis,* from the west coast of Columbia. *Ophidiaster chinensis,* off the coast of China. *Ophidiaster cribrarius,* from the Samoa Islands. *Ophidiaster germani* and *Ophidiaster pusillus,* from New Caledonia, the latter extending into the Eastern Archipelago. **Ophidiaster cylindricus,* from the Fiji Islands, and extending into the Eastern Archipelago and Indian Ocean.

β. Bathymetrical range: Shallow water to 450 fathoms.

γ. Nature of the Sea-bottom: Recorded in comparatively few cases. *Ophidiaster attenuatus* and *Ophidiaster ophidianus* were found by the Challenger on Volcanic mud, *Ophidiaster helicostichus* and *Ophidiaster tuberifer* on Coral mud, and *Ophidiaster cylindricus* on Coral reefs.

The localities of Lamarck's species *Ophidiaster arenatus* and *Ophidiaster bicolor* are unknown, and neither of the forms have been subsequently recognised.

The species collected by the Challenger are indicated in the foregoing list with an asterisk.

Chorological Synopsis of the Species herein mentioned.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Ophidiaster attenuatus	Atlantic.	450	Volcanic mud.
Ophidiaster cylindricus	Indian, Eastern Archipelago, and Pacific.	Shallow water.	On the reefs.
Ophidiaster helicostichus	Eastern Archipelago.	6	Coral mud.
Ophidiaster ophidianus	Atlantic.	450	Volcanic mud.
Ophidiaster tuberifer	Eastern Archipelago.	8	Coral mud.

1. *Ophidiaster attenuatus*, Gray.

Ophidiaster (*Hacelia*) *attenuatus*, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 284.
Asterias coriacea, Grube, 1840, Actin. Echin. u. Würm. d. Adriat. u. Mittelmeers, p. 22.
Ophidiaster attenuatus, Müller and Troschel, 1842, System der Asteriden, p. 29.

Locality.—Station 75. Between the Islands of Fayal and San Jorge, Azores. July 2, 1873. Lat. 38° 38′ 0″ N., long. 28° 28′ 30″ W. Depth 450 fathoms. Volcanic mud. Surface temperature 70°·0 Fahr.

2. *Ophidiaster ophidianus* (Lamarck), Agassiz.

Asterias ophidiana, Lamarck, 1816, Hist. nat. anim. s. vert., t. ii. p. 567.
Ophidiaster ophidianus, Agassiz, 1835, Mém. Soc. Sci. Nat. Neuchatel, t. i. p. 191.
Ophidiaster aurantius, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 284.

Locality.—Station 75. Between the Islands of Fayal and San Jorge, Azores. July 2, 1873. Lat. 38° 38′ 0″ N., long. 28° 28′ 30″ W. Depth 450 fathoms. Volcanic mud. Surface temperature 70°·0 Fahr.

Remarks.—I have referred with doubt to this species a single small example which measures R = 13·5 mm. The specimen is almost too small for accurate determination, but the form of the rays and the general character seem to me to be those of the species in question.

3. *Ophidiaster cylindricus* (Lamarck), Müller and Troschel.

Asterias cylindrica (*pars*), Lamarck, 1816, Hist. nat. anim. s. vert., t. ii. p. 567.
Ophidiaster cylindricus, Müller and Troschel, 1840 (April), Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, p. 103; System der Asteriden, p. 29.
Dactylosaster cylindricus, Gray, 1840 (December), Ann. and Mag. Nat. Hist., vol. vi. p. 283.
Linckia cylindrica, v. Martens, 1866, Archiv f. Naturgesch., Jahrg. xxxii., Bd. i. p. 85.
Ophidiaster asperulus, Lütken, 1871, Videnskab. Medd. naturh. Foren. i Kjøbenhavn, p. 274, tab. v. fig. 4.

Locality.—Kandavu, Fiji Islands. On the reefs.

4. *Ophidiaster tuberifer*, n. sp. (Pl. LXV. figs. 1–4).

Rays five. R = 48 mm.; $r = 7$ mm. $R < 7r$. Breadth of a ray near the base, 8 mm., and 5 mm. broad at about 7 or 8 mm. from the extremity.

Rays elongate, cylindrical, tapering slightly towards the tip, which is rather obtuse. Disk small, slightly convex. Interbrachial arcs subacute.

The abactinal and marginal plates, which are arranged with great regularity in seven longitudinal series, are small and slightly convex, and united by well-defined, slightly raised dissepiments. The plates and dissepiments are covered with rather large, rounded granules, those on the median region of the plate usually larger. Many of the plates bear a single, comparatively large, robust, conical, smooth tubercle, and on the outer part of the ray all the plates may be thus furnished, excepting the series on each side of the median radial line of plates. Small entrenched pedicellariæ of the characteristic figure-of-eight form, named by Perrier[1] "pédicellaires en salière," are frequent near the margin of the plates adjacent to a papular area, but there is much variation in different specimens as to the number of pedicellariæ present; and the same remark applies to the conical tubercles; on one example scarcely any tubercles are present.

The papular areas, which are very regular, and subcircular or slightly oval in outline, form six longitudinal series. They are slightly depressed, which gives great prominence to the plates and dissepiments, and are covered with small rounded granules, smaller than those on the plates; there are about ten to twelve papulæ in each, and occasionally more.

The actinal intermediate plates are covered with large, uniform, rounded granules, larger than those of the marginal plates, the whole so uniform and crowded that it is almost impossible to distinguish the separate plates.

The armature of the adambulacral plates appears to form three series, at least on the inner part of the ray. Of the inner or furrow spines there are two to each plate, and these form a continuous series along the furrow; they are short, obtuse, compressed laterally, and each alternate spinelet is rather larger than its companion. Immediately behind the furrow series is a single and rather shorter spinelet or papilliform granule, not quite midway between the large and small furrow spines, but rather nearer the former. Behind these and opposite the larger furrow spinelet is a robust fusiform spinelet, which forms an outer series similar to that found in *Ophidiaster* generally. In the interspaces between these spines small miliary granules are present, which extend up to the furrow series, and thus separate the spinelets or papillæ of the median series also.

Entrenched pedicellariæ similar to those on the abactinal area are present on the actinal intermediate plates immediately behind the large outer spines on the adambulacral plates. Sometimes a short series, fairly equidistantly spaced, occurs, but often only isolated ones are present. The number varies in different examples.

The madreporiform body, which is rather large and subcircular, is situated near the

[1] Révis. Stell. Mus., p. 125 (*Archives de Zool. expér.*, 1875, t. iv. p. 389).

margin of the disk, and its margin prevents the meeting of the lateral series of abactinal plates next the median radial series of the two adjacent rays. The striations are fine and sharply convoluted, the general trend being more or less regularly centrifugal. The primary apical plates on the disk are distinctly discernible.

The anal aperture is excentric in position, and is closed by a few small, valve-like, scutiform plates.

Colour in alcohol, a light brownish grey on the abactinal surface, mottled with darker patches of brown here and there, and with a number of the papular areas marked with a much darker shade of brown, the papular areas generally being darker than the plates and dissepiments, which gives a very ornate character to the species. The actinal surface is a bleached white.

Locality.—Station 186. In Torres Strait, off Cape York. September 8, 1874. Lat. 10° 30′ 0″ S., long. 142° 18′ 0″ E. Depth 8 fathoms. Coral mud. Surface temperature 77°·2 Fahr.

Remarks.—The nearest ally of this species appears to be *Ophidiaster granifer*, Lütken, but it is well distinguished by the six rows only of papular areas, by the great size of these and the numerous papulæ, by the character of the granulation and the presence of the large conical tubercles, by the small dumpy pedicellariæ, and by the peculiar form of the outer spinelets on the actinal surface of the adambulacral plates. The triple series of spinelets in the armature of the adambulacral plates recall the same intermediate character between *Ophidiaster* and *Linckia* as already noted in *Ophidiaster granifer* by Perrier.[1]

5. *Ophidiaster helicostichus*, n. sp. (Pl. LXIX. figs. 5–7).

Rays five. R = 130 mm.; r = 12·5 mm. R = 10·4 r. Breadth of a ray near the base, 13·5 mm.

Rays elongate and tapering gradually to the extremity. Disk small and slightly convex. Interbrachial arcs subacute.

The abactinal and marginal plates, which are arranged with great regularity, form seven longitudinal series. The plates of the median series are rather larger than the others, which are small in comparison to the size of the starfish, and all are united by broad, sharply defined dissepiments. The surface of the plates is very slightly convex, and is covered with a small, rounded, closely packed, and nearly uniform granulation, excepting round the margin of the papular areas where it is extremely small. None of the plates bear large granules or tubercles. Small entrenched pedicellariæ of the figure-of-eight form are occasionally present on the plates near the margin of the papular areas, but are not numerous.

The papular areas, which are large and rather deeply sunken, are subcircular or oval

[1] Révis. Stell. Mus., p. 128 (*Archives de Zool. expér.*, 1875, t. iv. p. 392).

in outline and form eight regular longitudinal series, the abactinal series on each side being much smaller than the others, gradually diminishing as they proceed along the ray and dying out altogether between the outer fourth and fifth of the ray. They are covered with small papilliform, almost spiniform or scutiform, granules, which are so arranged round the papular orifices that they trend over the apertures and appear to protect them almost in a valve-like manner. This produces the appearance of the area being occupied by a number of rosette-like bodies not very unlike the valvate pedicellariæ found in some forms of Archasteridæ. The papulæ are numerous, varying in number from ten to twenty.

The actinal intermediate plates are covered with large, rather irregular, rounded granules, which are larger than those on the marginal plates. At least three series of plates may be counted between the marginal and adambulacral plates at the base of the ray, a slight convexity of the plate and a depression at the angles assisting in the discernment of the plates.

The armature of the adambulacral plates is disposed in two series, in conformity with the usual arrangement in *Ophidiaster*. Of the inner or furrow series there are two spinelets to each plate, one much larger than the other, and these form a continuous uniserial series along the furrow, large and small spinelets alternating. The larger spinelet is very short, broad, expanding towards the tip, and obtusely rounded. It has the appearance at first sight of being compressed laterally, but when examined carefully with a magnifying-glass a median keel is seen on the outer surface which gives the papilla a subprismatic form, more or less subtriangular in section. The small alternating spinelets are much smaller, and little more than scutiform granules. The outer series of spinelets are placed close behind the furrow series, one standing opposite each of the small spinelets of the furrow series. They are small for the genus in comparison to the size of the starfish, but are robust, fusiform, compressed and almond-shaped; becoming on the outer part of the ray more conical and wider apart, appearing only to occur there on alternate plates. The interspaces between the spinelets of this series are occupied by small papilliform granules rather smaller than those on the actinal intermediate plates generally. Small entrenched pedicellariæ are occasionally present on the actinal intermediate plates immediately external to the outer spinelet of the adambulacral plates, and also, but apparently more rarely, on the other intermediate plates. A number of the pedicellariæ adjacent to the adambulacral spines are remarkable for the very large bosses present on each side of the constricted part of the figure-of-eight, much larger than any of the adjacent granules. The similarly-placed bosses on the pedicellariæ in the abactinal area are very small.

The madreporiform body is large and circular, and marked with very fine striations. It is situated external to a primary basal plate, and its lower margin masks the union of the two innermost plates of the lateral series of abactinal plates next the median radial series of the two adjacent rays. The granules on the plates which touch the lower

half of its margin are more papilliform than the other granules on the abactinal plates generally.

The anal aperture is small and excentric in position, and is surrounded by a number of small scutiform papillæ, which trend over the orifice.

The primary apical plates are very conspicuous.

Colour in alcohol, a brownish white, mottled with patches on the abactinal area of a light chocolate colour. All the papular areas are a dark greyish brown. This distribution of colour produces a very ornate appearance. The actinal surface is yellowish white.

Locality.—Station 187. Booby Island, Torres Strait. September 9, 1874. Lat. 10° 36′ 0″ S., long. 141° 55′ 0″ E. Depth 6 fathoms. Coral mud. Surface temperature 77°·7 Fahr.

Remarks.—This large and elegant form is distinct from any other species with which I am acquainted. It resembles in some of its details *Ophidiaster tuberifer*, but is readily distinguished by the larger size, the tapering rays, the absence of tubercles on the abactinal plates, the small size of the granulation on the abactinal plates, the peculiar character and disposition of the granulation of the papular areas, the difference in the adambulacral armature (which in *Ophidiaster helicostichus* is in two series, whereas in *Ophidiaster tuberifer* three series are present), and in the presence of the large-bossed pedicellariæ. The pedicellariæ generally are, if anything, smaller in the species under notice than in *Ophidiaster tuberifer*.

Genus *Leiaster*, Peters.

Leiaster (subgen.), Peters, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, April 1852, p. 177.
Lepidaster, Verrill, Trans. Conn. Acad. Arts and Sci., 1871, vol. i. part 2, p. 577 (non *Lepidaster*, Forbes, 1850).
Ophidiaster (*pars*), Perrier, Révis. Stell. Mus., p. 121 (Archives de Zool. expér., 1875, t. iv. p. 385).

This small group of species, although distinctly allied to *Ophidiaster*, appears to me worthy of generic recognition. The soft thick skin with which they are covered causes them to have a gelatinous or slimy character to the touch when alive, and this together with minor differences of structure produces a facies altogether different from that of any of the species of true *Ophidiaster*. Von Martens[1] and de Loriol[2] have both expressed the same opinion. *Leiaster*, as at present known, is confined to the Indian Ocean, the Eastern Archipelago, and the Pacific, and appears to be local in its occurrences.

Chorology of the Genus Leiaster.

a. Geographical distribution:—

Indian Ocean: Three species between the parallels of 10° and 30° S.
Leiaster coriaceus and *Leiaster glaber*, from Querimba Island.
Leiaster coriaceus and *Leiaster leachii*, from Mauritius.

[1] *Archiv f. Naturgesch.*, Jahrg. xxxii., Bd. i. p. 71.
[2] *Mém. Soc. phys. hist. nat. Genève*, t. xxix. p. 40.

Eastern Archipelago: One species between the parallels of 0° and 20° S.
Leiaster speciosus, from Flores, and extending into the Pacific.

Pacific: Two species between the parallels of 30° N. and 30° S.
Leiaster teres, from California. *Leiaster speciosus*, from the Fiji Islands, and extending into the Eastern Archipelago.

β. *Bathymetrical range:* All the species appear to be confined to shallow water.

γ. *Nature of the Sea-bottom:* *Leiaster speciosus* on Coral reefs.

Chorological Synopsis of the Species herein mentioned.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Leiaster speciosus . . .	Pacific.	Shallow water.	Coral reefs.

1. *Leiaster speciosus*, v. Martens.

Leiaster speciosus, v. Martens, 1866, Archiv f. Naturgesch., Jahrg. xxxii., Bd. i. p. 70.

Locality.—Kandavu, Fiji Islands. On the reefs.

Remarks.—The form which I have referred to this species is very nearly allied to *Leiaster leachii*, Gray; indeed the characters are almost identical. The rays, however, are broader, and pedicellariæ are present as in von Martens' species, but not nearly so numerous as in his type.

The skin which covers the whole of the animal in this species is remarkably thick and leathery; and Dr von Martens informs me that, in the case of his example from Flores, it was slimy and disagreeable to the touch when the animal was alive.

On a few of the inner series of spinelets on the adambulacral plates, on the inner part of the furrow, a slight trace of channelling may be detected here and there, but it is so faint that it has almost the appearance of having been obliterated by growth.

Genus *Linckia*, Nardo.

Linkia, Nardo, De Asteriis, Oken's Isis, 1834, p. 717.
Ophidiaster (*pars*), Müller and Troschel, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, April 1840, p. 103.
Linckia, Gray, Ann. and Mag. Nat. Hist., Dec. 1840, vol. vi. p. 284.
Acalia (subgen.), Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 285.

This well-known and essentially tropical genus presents a wide area of distribution, but is not known to extend beyond the 40th parallel north and the 30th parallel south of the Equator. Notwithstanding its great dispersion the genus maintains a remarkable uniformity of facies, and exhibits an extraordinarily small amount of morphological plasticity.

Chorology of the Genus Linckia.

α. Geographical distribution :—

Atlantic : Three species between the parallels of 40° N. and 20° S.
Linckia bouvieri and **Linckia guildingii*, from the Cape Verde Islands, and the latter also from the Bermudas, Antilles, Abrolhos reefs, Vera Cruz, and Bahia. *Linckia nodosa* from Tortugas.

Indian Ocean : Six species between the parallels of 30° N. and 30° S.
Linckia ehrenbergii, **Linckia miliaris*, and *Linckia multifora*, from the Red Sea and Mozambique ; the last two from Mauritius, and *Linckia miliaris* also from Zanzibar ; both extend into the Eastern Archipelago and Pacific. *Linckia erythræa* is reputed to be from the Red Sea. *Linckia marmorata* and **Linckia pacifica* from Mauritius ; the former is also recorded with doubt from Port Molle, Australia (*fide* Bell) ; *Linckia pacifica* also occurs off the Nicobar Islands and extends into the Pacific.

Eastern Archipelago : Three species between the parallels of 20° N. and 20° S.
**Linckia miliaris*, from Flores, Timor, Celebes, Batjan, the Philippine Islands and North Australia, and extending into the Indian and Pacific Oceans. *Linckia multifora*, from Flores, Celebes, Amboina, and extending into the Indian and Pacific Oceans. *Linckia rosenbergi*, a doubtful species from Amboina.

Pacific : Three or perhaps four species between the parallels of 30° N. and 30° S.
**Linckia miliaris* and *Linckia multifora*, from New Caledonia, and extending into the Eastern Archipelago and Indian Ocean ; the latter species is also found at the Sandwich Islands. **Linckia pacifica*, from Tahiti and Samoa, and extends into the Indian Ocean. *Linckia columbiæ*, from the west coast of Columbia.

β. Bathymetrical range : All the species are confined to shallow water.

γ. Nature of the Sea-bottom : Recorded in very few instances : frequently on coral reefs.

The localities of the following species are unknown, and the species themselves are of extremely doubtful value :—

Linckia franciscus, Nardo. | *Linckia intermedia*, Gray. | *Linckia pulchella*, Gray.

The species collected by the Challenger Expedition are indicated by an asterisk.

Chorological Synopsis of the Species herein mentioned.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Linckia guildingii . .	Atlantic.	...	...
Linckia miliaris . .	Indian, Pacific, and Eastern Archipelago.	Shallow water.	Coral reefs.
Linckia pacifica, var. *diplax*	Indian and Pacific.	Shallow water.	Coral reefs.

1. *Linckia guildingii*, Gray.

Linckia Guildingii, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 285.
Ophidiaster ornithopus, Müller and Troschel, 1842, System der Asteriden, p. 31.
Scytaster stella, Duchassaing, 1850, Anim. Radiaires des Antilles, p. 4.
Linckia ornithopus, Verrill, 1871 (1867), Trans. Conn. Acad. Arts and Sci., vol. i. part 2, p. 344.

Locality.—Porto Praya, St Jago, Cape Verde Islands. Depth and conditions not recorded.

2. *Linckia miliaris* (Linck), v. Martens.

Pentadactylosaster miliaris, Linck, 1733, De Stellis marinis, p. 34, tab. xxviii. No. 47.
Asterias lævigata (*pars*), Linné, 1766, Systema Naturæ, ed. xii., p. 1100.
Linkia typus, Nardo, 1834, De Asteriis, Oken's Isis, p. 717.
Ophidiaster lævigata, Müller and Troschel, 1840, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, April 1840, p. 103.
Linckia Brownii, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 285.
Linckia crassa, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 284.
Ophidiaster miliaris, Müller and Troschel, 1842, System der Asteriden, p. 30.
Ophidiaster clathrata, Grube, 1864, Jahresber. Schles. Gesellsch. Vaterl. Cultur, p. 51.
Linckia miliaris, v. Martens, 1866, Archiv f. Naturgesch., Jahrg. xxxii. Bd. i. p. 64.
Linckia lævigata, Lütken, 1871, Videnskab. Medd. naturh. Foren. i Kjøbenhavn, p. 267.

Localities.—Kandavu, Fiji Islands. On the reefs.
Zebu, Philippine Islands. On the reefs.

3. *Linckia pacifica*, var. *diplax* (Müller and Troschel).

Linckia pacifica, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 285.
Ophidiaster diplax, Müller and Troschel, 1842, System der Asteriden, p. 30.
? *Ophidiaster irregularis*, Perrier, 1869, Ann. Sci. Nat., 5e Série, t. xii. p. 253.
Linckia nicobarica, Lütken, 1871, Videnskab. Medd. naturh. Foren. i Kjøbenhavn, p. 265.

Localities.—Tongatabu. Depth and conditions not recorded.
Kandavu, Fiji Islands. On the reefs.

Genus *Nardoa*, Gray, *emend.*

Linckia (*pars*), Müller and Troschel, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, 1840, April, p. 103.
Nardoa, Gray, Ann. and Mag. Nat. Hist., 1840, Dec., vol. vi. p. 286.
Gomophia, Gray, Ann. and Mag. Nat. Hist., 1840, Dec., vol. vi. p. 286.
Scytaster (*pars*), Müller and Troschel, System der Asteriden, 1842, p. 34.
Ophidiaster (*pars*), Müller and Troschel, System der Asteriden, 1842, p. 28.
Scytaster (*pars*), Lütken, Videnskab. Medd. naturh. Foren. i Kjøbenhavn, 1864, p. 163.

The limits of the genus to which I have restored Gray's name of *Nardoa* are the same as those recognised by Perrier under the name of *Scytaster*. I fail to see the justice of the grounds on which Gray's name has been ignored by preceding writers. The following statements give the history of the case. In 1834 Nardo[1] established the genus *Linckia*, including in it three species, *Linckia typus*, *Linckia franciscus*, *Linckia variolosa* (err. typ. for *variolata*). In 1835 Agassiz[2] maintained the genus exactly as named and constituted by Nardo. In April 1840 Müller and Troschel[3] correctly discerned that the last of the three species above mentioned (*Linckia variolata*) represented a different generic type from the other two; but they erroneously referred *Linckia typus* (and subsequently in 1842 *Linckia franciscus*) to the genus *Ophidiaster* established by Agassiz in 1835, leaving only *Linckia variolata* in the genus *Linckia*, which they modified (by implication) for the reception of the form now known as *Fromia milleporella*. In December 1840 Gray[4] published the concluding part of his Synopsis of the Genera and Species of Starfish, and in this work the genus *Linckia* of Nardo is maintained, and the two species *Linckia typus* and *Linckia franciscus* duly referred to it. For the third species mentioned by Nardo, "*Linckia*" *variolata*, Gray established a new genus under the name of *Nardoa*. This course was perfectly correct and justifiable, and there could be no doubt or possible ambiguity about the type, as the species had been known and figured for more than a century.

In 1842 Müller and Troschel, in their classical work, System der Asteriden, unfortunately ignored altogether these clearly established genera, discarded *Linckia* as restricted by themselves two years previously, and proposed a new name, *Scytaster*, for a genus, the type of which was the *Nardoa variolata* of Gray (the *Linckia variolata* of Nardo), and associated with it species which are now recognised as the representatives of two other genera. This step appears to me to have been altogether unwarrantable.

Lütken[5] in 1864 and 1871 limited the scope of the genus *Scytaster*, and Perrier[6] still further in 1875. *Scytaster* as now understood is quite different in its scope from the

[1] De Asteriis, *Oken's Isis*, 1834, Heft vii. p. 717.
[2] *Mém. Soc. Sci. Nat. Neuchatel*, t. i. p. 191.
[3] *Monatsber. d. k. preuss. Akad. d. Wiss. Berlin*, April 1840, p. 103.
[4] *Ann. and Mag. Hist.*, vol. vi. p. 284.
[5] *Videnskab. Medd. naturh. Foren. i Kjøbenhavn*, for 1864, p. 163; for 1871, p. 279.
[6] Révis. Stell. Mus., p. 156 (*Archives de Zool. expér.*, 1875, t. iv. p. 420)

genus conceived by Müller and Troschel, and there is consequently no excuse on the ground of long established usage to set against the duty of restoring Gray's name of *Nardoa*. It is a simple act of justice, which cannot in honesty be passed over, as well as a means of keeping before naturalists the name of one whose work is worthy of remembrance. The use of the name in 1862 for a genus of Protozoa is no valid reason in my opinion against restoring *Nardoa* to its original signification.

Chorology of the Genus Nardoa.

α. *Geographical distribution:—*

Indian Ocean: Four species between the parallels of 30° N. and 30° S.

Nardoa variolata and *Nardoa ægyptiaca*, from the Red Sea and Mauritius, the former also from Mozambique, Rodriguez, and Ceylon, and the latter extending into the Pacific. *Nardoa galatheæ*, from the Nicobar Islands, and extending into the Eastern Archipelago. *Nardoa novæ-caledoniæ*, from Ceylon (*fide* Bell), and extending into the Pacific.

Eastern Archipelago: Five species between the parallels of 20° N. and 20° S.

Nardoa galatheæ, from Togean Island, and extending into the Indian Ocean. *Nardoa pauciforis*, from Flores. *Nardoa tuberculata* and *Nardoa obtusa*, from the Philippine Islands. *Nardoa semiregularis*, from Java, and extending into the Pacific.

Pacific: Five species between the parallels of 40° N. and 30° S.

Nardoa ægyptiaca, from the Samoa Islands (also from the Fiji Islands and Sandwich Islands, *fide* Perrier), and extending into the Indian Ocean. *Nardoa novæ-caledoniæ* and *Nardoa gomophia*, from New Caledonia, the former also from Ceylon (*fide* Bell). *Nardoa semiregularis*, from Japan, and extending into the Eastern Archipelago. *Nardoa semiseriata*, off the southern coast of China.

β. *Bathymetrical range:* All the species are confined to shallow water. *Nardoa semiseriata* in 40 fathoms.

γ. *Nature of the Sea-bottom:* Recorded in few instances. *Nardoa tuberculata* on coral reefs.

Chorological Synopsis of the Species herein mentioned.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Nardoa tuberculata . .	Eastern Archipelago.	Shallow water.	Coral reefs.

1. *Nardoa tuberculata*, Gray.

Nardoa tuberculata, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 287.
Ophidiaster tuberculatus, Müller and Troschel, 1842, System der Asteriden, p. 32.
Scytaster tuberculatus, Lütken, 1865, Videnskab. Medd. naturh. Foren. i Kjøbenhavn, 1864, p. 163.
Linckia tuberculata, v. Martens, 1866, Archiv f. Naturgesch., Jahrg. xxxii. Bd. i. p. 61.

Localities.—Samboangan, Philippine group. Depth 10 fathoms.
Zebu, Philippine Islands. On the reefs.

Genus *Narcissia*, Gray.

Narcissia, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 287.
Scytaster (*pars*), Dujardin and Hupé, Hist. Nat. Zooph. Échin. (Suites à Buffon), 1862, p. 368.

Although the differences presented by this form from the typical species of *Nardoa* are comparatively slight, their character and constancy appear to me sufficient to warrant the recognition of the genus as established by Gray.

An interesting additional species was obtained by the Challenger off the coast of Brazil.

Chorology of the Genus Narcissia.

α. *Geographical distribution*:—

Atlantic: Two species between the parallels of 40° N. and 20° S.
Narcissia canariensis, off the Canary Islands and Cape Verde Islands. | *Narcissia trigonaria*, off Bahia, Brazil.

β. *Bathymetrical range*: Not recorded.

γ. *Nature of the Sea-bottom*: Not recorded.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Narcissia canariensis . .	Atlantic.	...	...
Narcissia trigonaria . .	Atlantic.	...	...

1. *Narcissia canariensis*, d'Orbigny, sp.

Asterias canariensis, d'Orbigny, 1839, in Webb and Berthelot, Hist. Nat. Iles Canaries, t. ii., 2e partie, Zoologie, p. 148; Echin., pl. i. figs. 8–15.
Narcissia Teneriffæ, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 287.
Scytaster canariensis, Dujardin and Hupé, 1862, Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 368.

Locality.—St Vincent, Cape Verde Islands. Depth and conditions not recorded.

Remarks.—On the marginal plates of the example which I have referred to this

species are a few entrenched pedicellariæ, isolated, and at wide intervals apart. I am not aware that the presence of these organs has been noticed previously in this form.

2. *Narcissia trigonaria*, n. sp. (Pl. LXV. figs. 5–8).

Rays five. R = 62 mm.; r = 13 mm. R = 4·75 r. Breadth of a ray between the third and fourth infero-marginal plates, 12·5 mm.

Rays elongate, but much shorter than in *Narcissia canariensis*, rather broad, distinctly triangular in section, with a strongly-marked median keel, in which there is a conspicuous break at the base of the ray, separating the keel of the ray from the elevated part of the disk. The sides of the keel slope regularly to the margin. The actinal area is plane, rounded at the margin. The interbrachial arcs are subacute.

The abactinal plates are large along the keel on the inner half of the ray, somewhat irregular, and with a tendency to become tubercular. All the plates are covered with a minute, uniform granulation. The papulæ are single and isolated.

The marginal plates are well-defined and slightly convex. There are about thirty-seven infero-marginal plates between the median interradial line and the extremity. Papulæ are present, either singly or in pairs, between the infero-marginal and supero-marginal plates along the inner half of the ray, but do not occur on the outer half. Well-defined narrow channels are present between neighbouring plates.

The armature of the adambulacral plates is disposed in three series, each normally with four short papilliform spinelets. The spinelets of the inner or furrow series, which are the longest, are subequal, slightly flattened, broader at the tip than at the base, and obtusely rounded: they form a slightly radiating comb on the furrow margin. The second series, which is likewise composed of four or occasionally five spinelets, forms an obliquely disposed line, the adoral extremity being more remote from the furrow. Three of the spinelets are broader and more robust than the furrow series, are broad, flaring, and obtuse at the tip, with a tendency to assume more or less of a subprismatic shape; the adoral spine is much smaller than the others, and might often be counted with the outer series. The outer series are small, irregular, subprismatic papillæ, which may be pointed or chisel edges at the tip; they are little more than granules, and very slightly larger than the granules on the adjacent intermediate plates.

One longitudinal series of actinal intermediate plates extends nearly to the extremity of the ray. The actinal interradial regions of the disk are small, and, although there are four intermediate plates on each side of the median interradial line, the series they represent do not extend beyond the base of the rays, the fifth infero-marginal plate being contingent on the first series of intermediate plates above-mentioned. The plates of the first series of intermediate plates are well defined by intervening channels. The granules on the intermediate plates are rather larger than those on the marginal plates and are distinctly spaced. There do not appear to be any papulæ on the actinal surface.

The madreporiform body is small and subtriangular in form, the angles of the triangle being rounded. It is situated rather nearer the centre than midway between that point and the margin, and lies within the steep declivity of the median interradial line. The striæ upon its surface are very fine and show much convolution. The anal aperture is distinct and excentric in position, being situated by the side of the large dorso-central plate.

Colour in alcohol, a bleached yellowish grey.

Locality.—Off Bahia. Depth and conditions not recorded.

Remarks.—This species may be distinguished from *Narcissia canariensis* by the shorter and broader rays, by the tubercular character of the abactinal plates on the median keel of the rays, by the large size and convexity of the marginal plates, as well as by the difference in the adambulacral armature. The two forms are, however, closely allied.

Subfamily Metrodirinæ, Sladen, 1888.

Genus *Metrodira*, Gray.

Metrodira, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 282.
Scytaster (*pars*), Müller and Troschel, System der Asteriden, 1842, p. 34.

The aberrant characters of this genus have led me to place it in a distinct subfamily. Its external facies and general structure appear to indicate an intermediate position between the Linckiidæ and Echinasteridæ, but a knowledge of its internal anatomy, which unfortunately the material at my disposal does not enable me to supply, is desirable before the relationships of *Metrodira* can be more critically discussed.

Chorology of the Genus Metrodira.

α. Geographical distribution:—

Eastern Archipelago: One species between the parallels of 20° N. and 20° S. *Metrodira subulata*, from Migupou and Torres Strait, and extending into the Pacific.

Pacific: Two species between the parallels of 30° (?) N. and 50° S. *Metrodira subtilis*, off the coast of China. *Metrodira subulata*, from George Sound, New Zealand, and extending into the Eastern Archipelago.

β. Bathymetrical range: Probably confined to Shallow water. *Metrodira subulata* in 8 fathoms.

γ. Nature of the Sea-bottom: Metrodira subulata on Coral mud.

Chorological Synopsis of the Species herein mentioned.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Metrodira subulata . .	Eastern Archipelago.	8	Coral mud.

1. *Metrodira subulata*, Gray.

Metrodira subulata, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 282.
Scytaster subulatus, Müller and Troschel, 1842, System der Asteriden, p. 36.

Locality.—Station 186. In Torres Strait, off Cape York. September 8, 1874. Lat. 10° 30′ 0″ S., long. 142° 18′ 0″ E. Depth 8 fathoms. Coral mud. Surface temperature 77°·2 Fahr.

Family Zoroasteridæ, Sladen, 1888.

The genus *Zoroaster* was originally classified by Sir Wyville Thomson[1] in the Asteriidæ. It was subsequently referred by Perrier[2] to the family Pedicellasteridæ, established by him in 1884. In the following year, 1885, it was, however, removed by Perrier[3] into the new family Stichasteridæ. In my opinion *Zoroaster* and its allies are very far removed from *Pedicellaster*, and, although in some of their characters they approach much more nearly *Stichaster*, I consider that the details of their structure justify the establishment of an independent family.

I include in this family the genera *Zoroaster*, *Cnemidaster*, and *Pholidaster*.

Genus *Zoroaster*, Wyville Thomson.

Zoroaster, Wyville Thomson, The Depths of the Sea, 1873, p. 154.

Disk small. Rays long, narrow, tapering throughout, arched abactinally and with a more or less definite median keel, tumid actinally. Interbrachial arcs acute.

Abactinal, marginal, and actinal intermediate plates arranged in regular longitudinal lines along the ray. Regular transverse series are also formed, the plates being correspondent and equal in length in each series as they proceed along the ray, excepting the plates in the median series, which are larger. The surface of all the plates is covered with small widely-spaced granules, upon which are articulated small, papilliform, skin-covered spinelets. A small robust conical spine may be borne on the plates of the median series,

[1] The Depths of the Sea, 1873, p. 154.
[2] *Nouv. Archives Mus. Hist. Nat.*, 2e Série, t. vi., p. 167 and p. 195.
[3] *Ann. Sci. Nat.* (Zool.), 1885, t. xix., art. No. 8, p. 15.

the supero-marginal series, and sometimes on the intermediate abactinal series of plates; and one or more longer, delicate, tapering spines are usually present on each of the actinal intermediate plates.

Adambulacral plates small and quite within the furrow, and each alternate plate may be produced and form a prominent ridge which extends far into the furrow (this character probably only fully developed in the adult). Adambulacral armature consisting of several elongate spines placed in single file along the edge of the ridge; and one or two small ciliary spinelets at the extreme edge of the plate. The intermediate non-prominent plates bear only this small group of ciliary spinelets, and are devoid of spines on the surface of the plate within the furrow.

Madreporiform body small and inconspicuous, placed external to an interradial (basal) plate.

Anal aperture small, excentric, surrounded by a circlet of small ciliary spines.

Small forficiform pedicellariæ are present on the abactinal surface, one or occasionally two being borne on the membrane in each mesh punctured by the papulæ. Several small forficiform pedicellariæ are attached by membrane to the innermost spine of the armature of the adambulacral plates.

Ambulacral tube-feet small, with a fleshy terminal disk; forming four rows.

Remarks.—This genus was known hitherto only from the Atlantic; a new form has, however, been added by the Challenger from the Eastern Archipelago. All the species are from great depths.

Chorological Synopsis of the Genus Zoroaster.

α. Geographical Distribution:—

Atlantic: Five species between the parallels of 60° N. and 10° S.

**Zoroaster fulgens*, in the Faeröe Channel, off the coast of Morocco, and the Sahara; off the coast of North America; and off Pernambuco. *Zoroaster longicauda*, off the Azores, Senegal, and the Sahara. *Zoroaster diomedeæ*, off the coast of North America. *Zoroaster ackleyi* and *Zoroaster sigsbeei*, from the Gulf of Mexico, the former off Montserrat and Santa Cruz, the latter off St Kitts, and in lat. 28° 42′ N., long. 88° 40′ W. (The reference of *Zoroaster sigsbeei* to this genus seems to me doubtful.)

Pacific: One species between the parallels of 0° and 10° S.

**Zoroaster tenuis*, off the coast of New Guinea.

β. Bathymetrical range: 38 to 2326 fathoms.

Zoroaster fulgens, *Zoroaster longicauda*, and *Zoroaster tenuis* are confined to the Abyssal zone. *Zoroaster diomedeæ* extends from the Littoral zone

into the Abyssal zone. *Zoroaster ackleyi* and *Zoroaster sigsbeei* do not extend below the Continental zone, but the former is also found in the deep water of the Littoral zone.

Greatest range of one species: *Zoroaster diomedeæ*, 38 to 1555 fathoms.

γ. *Nature of the Sea-bottom: Zoroaster fulgens* and *Zoroaster tenuis* on Blue mud, the former was also found on Red mud off Pernambuco (in 675 fathoms). *Zoroaster diomedeæ* on Globigerina ooze. *Zoroaster ackleyi* on coarse sand and broken shells. *Zoroaster sigsbeei* on fine sand.

The species collected by the Challenger are indicated in the foregoing list by an asterisk.

Chorological Synopsis of the Species herein mentioned.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Zoroaster fulgens . . .	Atlantic.	500 to 1350.	Blue mud; Red mud.
Zoroaster tenuis . . .	Pacific.	1070.	Blue mud.

1. *Zoroaster fulgens*, Wyville Thomson (Pl. LXVI. figs. 1 and 2; Pl. LXVIII. figs. 1 and 2).

Zoroaster fulgens, Wyville Thomson, The Depths of the Sea, 1873, p. 154, fig. 26.

Rays five. R = 125 to 130 mm.; r = 14 to 15 mm. R > 8·5 r. Breadth of a ray at the base, 17 mm.

Rays very long, narrow, subcylindrical, and tapering throughout to a finely pointed extremity; arched on the abactinal surface, and tumid on the actinal surface on each side of the furrow, which is deeply sunken. Interbrachial arcs acute.

The disk is rather higher than the rays and slightly tumid. The calcareous skeleton of the whole test is formed of suboval or subhexagonal plates, disposed in perfectly regular longitudinal and transverse series. The following is the arrangement they present. Surrounding a dorso-central and five small radially placed under-basal plates, are five large basal plates interradial in position; and outside and alternating with these are five similar but rather smaller radially placed plates, the primary radials. Outward from each of the radial plates proceeds a longitudinal series of plates which extends along the median abactinal line of the ray, each plate regularly subhexagonal in form, and touching or slightly imbricating upon its next serial companion. On each side of this median line of plates is a parallel line of smaller plates, and these are succeeded by a series of plates nearly equal in size to those of the median line; the outer of these lines standing on the convexity which separates the abactinal and lateral areas of the ray. Between this series

of supero-marginal plates and the adambulacral plates are five longitudinal and parallel series of plates, the three upper rows forming the sides of the ray and the two lower being on the tumid actinal surface. The plates of the two upper rows of the lateral series are broader than those in the three lower series. The longitudinal arrangement of all the series is perfectly regular, and the plates diminish gradually in size as they proceed outward. Excepting the median radial line, the plates of all the other rows form regular transverse, as well as longitudinal series. The plates of the median radial line are slightly larger than the others and consequently do not correspond. All the plates are contiguous, but leave a small diamond-shaped or subcircular mesh between the rounded corners of adjoining plates. This is covered with membrane, through which one or more small papulæ proceed, and on which are usually borne one, or occasionally two, small forficiform pedicellariæ. The meshes form perfectly regular longitudinal lines, and this character, as well as their presence, is rendered more conspicuous by the slightly tumid surface of the plates. The surface of all the plates is studded with a number of small, uniform, well-spaced, miliary granules, on which are articulated very short ciliary spinelets thinly covered with membrane. The plates of the median radial series are submammillated, rising to a small but definite tubercle in the middle, which gives attachment to a short, robust, conical spinelet, the surrounding portions of the plate being covered with the same small miliary granules and spinelets as the other plates. The supero-marginal plates are usually similarly mammillated and spined, and in fully grown examples the large interradial plates on the disk and the series of intermediate plates between the median and the supero-marginal series may also bear a spine. The spines on the intermediate series of plates are, however, by no means regular or constant.

On the plates of the three rows of actinal intermediate plates, which succeed the adambulacral plates, there are usually one to three spinelets much longer and more robust than the accompanying miliary spinelets. These are naked, delicate, cylindrical, and taper to a fine extremity, and are generally arranged in slightly oblique lines, with the middle spine often more forward and longest when three are present, near the lower margin of the plate; they are also directed upward and appressed to the ray. The next row on the sides of the ray, *i.e.*, the fourth series of actinal intermediate plates from the adambulacral plates has one larger spine on each plate of equal size to those just mentioned.

The adambulacral plates are quite within the furrow, and are short but broad, extending far upward almost vertically. Each alternate plate is developed into a thin prominent ridge, which extends far into the furrow and entirely separates neighbouring tube-feet, whereas the intermediate plates are smooth, and appear to form the true furrow wall. The armature of the prominent adambulacral plates consists of four spines, which are moderately long, cylindrical, and slightly tapering, placed in single file at intervals along the edge of the ridge, the innermost being usually the most delicate, and the outermost usually the shortest. Two to five small forficiform pedicellariæ are attached by membrane

to the extremity of the delicate innermost spine. One or two small ciliary spines may be present on the extreme outer edge of the adambulacral plate, adjacent to the first longitudinal row of intermediate plates; and two or three similar small spines are present in the same position at the outer edge of the non-prominent intermediate adambulacral plates, but no spines whatever are present on the surface of these plates within the furrow.

The actinostome is deeply depressed, and the mouth-plates are entirely within the cavity, and are not apposable. Their armature consists of pointed, moderately robust spines similar to the larger spines on the ridges of the adambulacral plates.

The madreporiform body, which is small and inconspicuous, is placed external to one of the interradial (basal) plates.

The anal aperture is small, distinct, surrounded by a circlet of small ciliary spines, and is placed at the side of the dorso-central plate, and consequently slightly excentric in position.

The ambulacral tube-feet form four rows. They are rather small, subconical, and have a small but distinct fleshy terminal disk.

Young Phase.—The young form,[1] measuring R = 11 mm., $r = 2{\cdot}25$ mm., has a very remarkable appearance, owing to the prominence and distinctness of the component parts of the skeleton. The disk is much higher than in the adult. The dorso-central plate is prominent and assumes the shape of a rounded cone. The basal or interradial and first radial plates are of nearly equal size, and are very tumid or almost semiglobular in form. The plates of the median radial line are large and distinct, occupying a large portion of the abactinal surface of the ray. The supero-marginal series of plates form the margin of the ray and the intermediate plates are small. Between the supero-marginal series and the adambulacral plates there are not more than two fully developed longitudinal rows of plates, with a partially developed series commencing to appear between the latter and the adambulacral plates. The terminal (ocular) plates are very large, somewhat resembling the shape of a serpent's head, and are armed with one or two pairs of comparatively large robust spinelets, near the extremity, which are directed upward.

The large plates of the disk and the median radial series have already a small tubercle, but only some of these bear spinelets. All the plates have a few widely spaced and very minute granules and microscopic ciliary spinelets. The spinelets on the lower rows of plates are comparatively long and well developed. The character of the alternate prominent adambulacral plates is already discernible, although not more than one or two spinelets are present in the armature of each.

The madreporiform body is outside and external to the interradial or basal plate, and almost in the ravine of the interbrachial arc. The anal aperture is excentric, and

[1] I have given a drawing of this young example in my account of the Asteroidea dredged during the cruise of H.M.S. "Triton" (*Trans. Roy. Soc. Edin.*, 1883, vol. xxxii. pl. xxvi. figs. 9–11).

situated between the dorso-central plate and a basal plate, standing in the right posterior interradium when the madreporiform body is placed in the right anterior interradium.

Localities.—Station 46. Off the coast of North America, east of New Jersey and Long Island. May 6, 1873. Lat. 40° 17′ 0″ N., long. 66° 48′ 0″ W. Depth 1350 fathoms. Blue mud. Bottom temperature 40°·0 Fahr.

Station 50. South of Halifax, Nova Scotia. May 21, 1873. Lat. 42° 8′ 0″ N., long. 63° 39′ 0″ W. Depth 1250 fathoms. Blue mud. Bottom temperature 38°·0 Fahr.; surface temperature 45°·0 Fahr.

Station 120. Off Pernambuco. September 9, 1873. Lat. 8° 37′ 0″ S., long. 34° 28′ 0″ W. Depth 675 fathoms. Red mud. Surface temperature 78°·0 Fahr.

"Porcupine" Expedition:

Station 87, 1869.[1] North-west of the Hebrides. Lat. 59° 35′ N., long. 9° 11′ W. Depth 767 fathoms. Bottom temperature 5°·2 C.; surface temperature 11°·4 C.

"Triton" Expedition:

Station 11. In the Faeröe Channel. August 28, 1882. Lat. 59° 29′ N., long. 7° 13′ W. Depth 555 fathoms. Bottom temperature 45°·5 Fahr.

Station 13. In the Faeröe Channel. August 31, 1882. Lat. 59° 51′ 2″ N., long. 8° 18′ 0″ W. Depth 570 fathoms. Bottom temperature 45°·7 Fahr.

2. *Zoroaster tenuis*, n. sp. (Pl. LXVII. figs. 1 and 2; Pl. LXVIII. figs. 7 and 8).

Rays five. $R = 15{\cdot}5$ mm.; $r = 2{\cdot}5$ mm. $R = 6{\cdot}2\ r$. Breadth of a ray near the base, 3 mm.

Rays elongate, delicate, tapering from the base to the extremity, roundly carinate abactinally. Disk convex and high abactinally. Interbrachial arcs acute.

The centre of the disk is occupied by a large dorso-central plate, which is elevated centrally into a large, broad-based, conical eminence. This is surrounded by five small subquadrate under-basal plates; and then follow five large irregularly subpentagonal basal plates with festooned margins: the latter series do not fit close up to the under-basals, but are separated by a small membranous space from them and the free portions of the dorso-central plate. The succeeding primary radial plates, which also have festooned margins, pass far between the basal plates towards the under-basal plates, but are separated from them by a space about equal to the length of the latter, in which perhaps a small intermediate plate may be present, but I am unable to say definitely without injuring the specimen. The succeeding median radial plates are large and occupy nearly the whole of the breadth of the ray, being separated from the marginal plates by only a series of very small plates, which does not extend to the extremity. Single isolated papulæ occur on each side of these small plates. The plates of the median radial series are strongly bent and each bears on the centre of the keel a comparatively large robust

[1] This Station is recorded in "The Depths of the Sea," but I have not seen any specimens from it.

conical spinelet, and on the surface of the plate a few small, equal, isolated, widely spaced, miliary spinelets. The basal plates are also similarly armed with a central conical spinelet and a few widely spaced miliary spinelets. The under-basals only bear miliary spinelets, and a few are present on the flanks of the dorso-central plate.

The supero-marginal plates, about twenty in number from the median interradial line to the extremity, are large and narrowed abactinally (at least at the base of the ray), leaving small angular spaces in which the papular orifices are found. Each plate bears one large central spinelet and several smaller ones. The infero-marginal plates are much smaller than the supero-marginal series, diminish rapidly in size as they proceed along the ray, and do not reach the end of the ray, the adambulacral plates being there contingent on the supero-marginal series. Each plate, before they become very small, bears a large conical spinelet and two or three smaller ones.

The adambulacral plates are small, rather broader than long, and with an angular prominence into the furrow; all the plates being equally prominent into the furrow. Their armature consists of a transverse series of three cylindrical tapering spinelets, nearly as large as the largest spinelet on the marginal plates. The innermost spinelet, which is rather smaller than the other two, stands at the apex of the angular prominence and is directed over the furrow, the other two are equidistantly spaced on the actinal surface of the plate and radiate slightly apart. The median spinelet is usually slightly the longest. About seven adambulacral plates are included within the wide actinal groove of the terminal plate.

The mouth-plates trend upward towards the buccal cavity, and they bear on their surface two large robust actinal spines. The actinostome is large.

I have found no trace of any actinal intermediate plates between the infero-marginal and the adambulacral plates.

The madreporiform body is small and very difficult to see. It is situated between the basal plate and the innermost pair of supero-marginal plates, and is consequently quite at the edge of the disk. Its surface is traversed by what may be described as three or four very coarse ridges rather than striations, and it is essentially embryonic in character.

The anal aperture, which is large and excentric in position, is situated between the dorso-central and basal plate, the margin of the former being deeply lunated for its reception. Several papilliform spinelets surround the orifice.

The ambulacral tube-feet, which are arranged in two simple and regular rows, have fleshy terminal knob-like disks, which appear to be capable of invagination.

The terminal plate is very large and deeply indented adcentrally for the reception of the termination of the median radial series of plates. It bears three large spinelets on each side near the extremity, and there appears to be a prominence in the median line abactinally on which a spine was probably originally borne. In addition to these, isolated miliary spinelets are also present on the surface.

Colour in alcohol, a bleached greyish white.

Locality.—Station 218. Off the north coast of New Guinea, south-west of the Admiralty Islands. March 1, 1875. Lat. 2° 33′ 0″ S., long. 144° 4′ 0″ E. Depth 1070 fathoms.. Blue mud. Bottom temperature 36°·4 Fahr.; surface temperature 84°·0 Fahr.

Genus *Cnemidaster*, n. gen.

Disk small. Rays long, delicate, cylindrical, more or less rigid. Interbrachial arcs rounded.

Abactinal plates arranged in a single, regular, longitudinal line along the ray, covered with thin skin and bearing no granules or spinelets. Abactinal covering of disk composed of the primary apical plates, all large and convex, covered with thin skin and bearing no granules or spinelets.

Supero-marginal larger than the infero-marginal plates; both series covered with skin and bearing no granules or spinelets (excepting a few of the infero-marginal plates in the interbrachial arc, which may bear appendages similar to those on the actinal intermediate plates).

Actinal intermediate plates, two series present bearing small compressed sacculated spinelets, appressed to the ray and forming longitudinal series along the ray.

Adambulacral plates broader than long, with a prominent angle into the furrow (all equally prominent), and a transverse median keel. Armature consisting of a transverse series of short spinelets, equidistantly spaced on the keel.

Madreporiform body small, circular, exposed, situated external to the adjacent primary basal plate.

Anal aperture distinct, excentric in position.

No pedicellariæ.

Ambulacral tube-feet with a fleshy terminal knob, and forming two simple regular rows.

Remarks.—This genus is distinguished from *Zoroaster* and the other forms in this family by the large skin-covered abactinal and marginal plates, devoid of spinelets or granules of any form. The armature of the actinal intermediate and of the adambulacral plates is also characteristic. The starfish described by Perrier[1] under the name of *Zoroaster sigsbeei* is perhaps more nearly related than any other form known to me; but the description and the figure are both insufficient to enable me to say how close the relationship may be.

[1] *Bull. Mus. Comp. Zoöl.*, Harvard, 1881, vol. ix. p. 5; *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi. p. 195, pl. iii. fig. 2.

Chorology of the Genus Cnemidaster.

α. Geographical distribution:—

EASTERN ARCHIPELAGO: One species between the parallels of 0° and 10° S.

Cnemidaster wyvillii, in the Arafura Sea, north-west of the Arrou Islands.

β. Bathymetrical range: 800 fathoms.

γ. Nature of the Sea-bottom: Green mud.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Cnemidaster wyvillii . .	Eastern Archipelago.	800	Green mud.

1. *Cnemidaster wyvillii*, n. sp. (Pl. LXVII. figs. 3 and 4; Pl. LXVIII. figs. 3 and 4).

Rays five. R = 22 mm., $r = 4{\cdot}25$ mm. $R > 5\ r$. Breadth of a ray near the base, 3·5 mm.

Rays elongate, cylindrical, slightly flattened actinally, tapering from the base to the extremity. Interbrachial arcs rounded. Disk convex abactinally.

The disk, which is higher than the rays and regularly convex, is occupied entirely by the primary apical plates, each slightly convex or tumid, which are arranged in the following manner. The centre is occupied by the dorso-central plate, which is large, almost subconically convex, pentagonal in outline—the angles being more or less rounded, and the right posterior side somewhat encroached upon for the anal aperture. Contingent on the dorso-central is a complete cycle of five basal plates, rather irregular in shape, apparently quadrangular in form, but probably more or less hexagonal, which are smaller than the dorso-central. External to these are the five primary radial plates, irregularly subhexagonal in form, larger than the basal plates, and either equal in size to the dorso-central or slightly less; they are inserted far down between the basal plates, but do not reach the dorso-central. The second radial plate is smaller than the first, hexagonal in form, and broader than long. In the third the length and breadth are equal. In the radial plates beyond the third and up to the middle of the ray the length is greater than the breadth, but on the outer half of the ray the breadth is greater than the length. Isolated single papulæ occur at the angles of the plates, but do not extend much beyond the inner half of the ray. The plates of the series on each side of the median radial series are rather smaller, and have the breadth greater than the length on the inner part of the ray, but

subequal on the outer part. This series forms the margin of the ray, and is probably the supero-marginal series of plates. The plates of the next series (the infero-marginal), which also extend to the extremity, are rather smaller, and all are longer than broad. Between these and the adambulacral plates are two series of actinal intermediate plates all much longer than broad. The abactinal and the two series of marginal plates were covered with a very thin skin, and do not appear to have borne any spines, excepting the innermost two or three plates of the infero-marginal series, whose armature resembles that of the adjacent intermediate plates. The actinal intermediate plates bear short, equal, broad, compressed, lanceolate, pointed spinelets, all in thin membranous sacs, appressed to the ray and arranged in a line upon the plate, forming longitudinal series along the ray.

The adambulacral plates are broader than long, definitely spaced, with a prominent angle towards the furrow, and a slight convexity or keel along the median transverse line of the actinal surface at right angles to the furrow. All the plates are equally prominent into the furrow. Their armature consists of a transverse lineal series of five short spinelets equidistantly placed on the keel, the innermost or furrow spine being the smallest, tapering and pointed, the other four subequal or diminishing in size as they recede from the furrow, much broader, compressed, and more or less sublanceolate in form, radiating slightly apart, and usually appressed to the ray, the direction being aboral and slightly outward.

The mouth-plates trend upward into the buccal cavity. The actinostome is large and its margin declivous.

The madreporiform body, which is small, circular, and convex, is situated external to the adjacent primary basal plate. Its surface is grooved with very few, coarse, convoluted striæ.

The anal aperture is distinct and excentric, situated between the dorso-central and the right postero-lateral basal plate, the margin of the latter being lunated for its reception.

The ambulacral furrow is wide. The tube-feet, which are arranged in two simple and regular rows, have fleshy terminal knobs or disks.

The terminal plate, which is large and elongate, is deeply indented posteriorly on the abactinal surface for the insertion of the last three or four median radial plates. It bears at the extremity two pairs of comparatively large, conical, pointed spinelets, and several smaller ones.

Colour in alcohol, bleached white on the abactinal surface, where the membrane has been abraded from the plates. Traces, however, of the membrane, which are of a dark purplish brown, are present at the angles and in the sutures between the plates; and in the present condition of the specimen preserved in spirit give a remarkably ornate character to this species. The actinal surface is light brown. The colour of the ambulacral tube-feet is very dark brown, the terminal knob, which is much lighter, being almost white.

Locality.—Station 191. In the Arafura Sea, north-west of the Arrou Islands. September 23, 1874. Lat. 5° 41′ 0″ S., long. 134° 4′ 30″ E. Depth 800 fathoms. Green mud. Bottom temperature 39°·5 Fahr.; surface temperature 82°·2 Fahr.

Genus *Pholidaster*, Sladen.

Pholidaster, Sladen in Narr. Chall. Exp., 1885, vol. i., p. 616.

Disk small. Rays long, tapering, subcylindrical and flexible. Interbrachial arcs acute.

Abactinal plates arranged in regular longitudinal series (the median radial series largest), bearing large plate-like skin-covered scales, which mask all the plates except some of the primary apical plates on the disk and the median radial series along the ray. Small isolated papulæ are present at the angles of the plates.

Supero-marginal plates subequal in size to the median radial series of plates, and bearing plate-like skin-covered scales similar to those above described. Infero-marginal plates smaller than the superior series and bearing a single, delicate, elongate, naked lateral spine appressed to the ray, and several compressed, scale-like, skin-covered spinelets.

Actinal intermediate plates two or three series, each plate bearing a single naked spinelet similar to the lateral spine, appressed to the ray, and several skin-covered papillæ; the large spines forming longitudinal series along the ray.

Adambulacral plates broader than long, each alternate plate with a prominent ridge which extends far into the furrow, the intermediate plates appearing to form the straight wall of the furrow. Adambulacral armature consisting of a pair of delicate furrow spines, which radiate apart at the inner end of the ridge; on the outer part of the plate is a group of skin-covered papillæ parallel to the furrow. The intermediate non-prominent adambulacral plates only bear the group of skin-covered papillæ, and a few more prominent extending to the margin of the furrow.

Madreporiform body more or less masked by the plate-like scales of the abactinal plates; the striations appear to be few in number and coarse.

Anal aperture inconspicuous and excentric; closed by squamiform plates.

No pedicellariæ present.

Ambulacral tube-feet with a terminal fleshy knob; crowded and forming four alternating rows.

Remarks.—This genus is unquestionably related to *Zoroaster*, of which it is probably the shallow-water representative in this tropical area. *Pholidaster* is, however, readily distinguished from *Zoroaster* and from all other known forms by the presence of the remarkable scales borne on the abactinal and marginal plates. So far as at present known the genus has a very small area of distribution.

Chorology of the Genus Pholidaster.

a. Geographical distribution:—

Eastern Archipelago: Two species between the parallels of 20° N. and 10° S.

Pholidaster squamatus off the Philippine Islands. *Pholidaster distinctus* in the Banda Sea, between the Ki Islands and the Banda Islands.

β. *Bathymetrical range:* 100 to 140 fathoms. The genus is thus confined to the Littoral zone.

γ. *Nature of the Sea-bottom: Pholidaster squamatus* is found on Green mud; *Pholidaster distinctus* on Blue mud.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Pholidaster distinctus .	Eastern Archipelago.	140	Blue mud.
Pholidaster squamatus .	Eastern Archipelago.	100	Green mud.

1. *Pholidaster squamatus*, n. sp. (Pl. LXVII. figs. 5 and 6; Pl. LXVIII. figs. 5 and 6).

Rays five. R = 75 mm.; r = 8 mm. R<9·5 r. Breadth of a ray near the base, 8 to 8·5 mm.

Rays elongate, semicylindrical, rounded abactinally, flattened actinally, tapering from the base to the extremity. Interbrachial arcs acute. Disk very slightly higher than the base of the rays, faintly convex.

All the plates on the abactinal surface, excepting the median radial series and some of the primary apical plates on the disk are masked by large skin-covered scales, each distinct and appressed to the ray, looking at first sight more like well-defined plates than scales. The centre of the disk is occupied by a circular dorso-central plate, the surface of which is smooth and covered with thin skin, and the margin surrounded with a compact ring of skin-covered scales. External to this may be seen in some examples five small under-basal plates, which are circular, smooth, and surrounded by a ring of scales like the dorso-central plate. In other examples, however, the under-basal plates are masked and the space between the dorso-central and the primary radials is occupied by scales, as in Pl. LXVII. fig. 5, which look like polygonal close-fitting plates. The primary radial plates are large, irregularly oval transversely, smooth, and surrounded by a ring of scales. The succeeding median radial plates are all broader than long and are separated from one another by a straight row of five subquadrangular scales, the outer one at each end of the series being rather larger than the three central ones, attached to the outer margin of the plate, the free end of the scale being directed outward. The breadth of the median radial series of plates is one third of the breadth of the ray. On each side of the median radial series is a series of small plates, which bear a single large scale, but sometimes a large one and a small one are present, by which they are entirely masked. External to these is a series of large marginal plates, much broader than long, which bear two sub-

regular transverse parallel rows of tubercular eminences on which are attached large flat scales; the upper ones are large, irregularly fan-shaped, as broad as long; the lower ones are more elongate, lanceolate in form, and more or less pointed, all closely appressed. A well-defined channel occurs between this series and the infero-marginal plates, and single isolated papulæ are present between the plates. The next series of plates, which may be regarded from their position as the representatives of the infero-marginal plates, are smaller (in breadth) than the superior series; each of these bears normally a single, naked, elongate, delicate, tapering and more or less compressed lateral spine, near the actinal margin of the plate, which is directed outward and upward, and appressed to the ray; the longest measures between 3 and 4 mm. Above this lateral spine are two pairs of small almond-shaped, or lanceolate, and pointed scale-like spinelets, the upper pair forming a lineal series throughout the ray and partially masking the channel above described. There may also be two or three small miliary papillæ or scutes near the base of the lateral spine. Single isolated papulæ are present between the infero-marginal and actinal intermediate plates. There are three rows of closely fitting actinal intermediate plates between the infero-marginal and adambulacral plates, which form regular longitudinal and transverse series. Each plate bears a single large spinelet, similar and nearly equal in size to the lateral spine, articulated on a prominent tubercle, and several small miliary papillæ.

The adambulacral plates are small, broader than long, and well spaced, the interspace being filled with muscular tissue. Each alternate plate is developed into a thin, comparatively large, prominent ridge, which extends far into the furrow, and separates the neighbouring tube-feet; whilst the intermediate plates are smooth and appear to form the true furrow wall. The armature of the prominent adambulacral plates consists of a pair of small and very delicate spines situated at the extreme inner end of the ridge and consequently high in the furrow, which radiate rather widely apart; behind these and on the surface of the ridge is either a single spine, or a pair of spines placed obliquely, and about equal in size to the furrow spines; and these are followed by either one or two similar and similarly placed spinelets. On the outer part of the plate is a group of small, subequal, compressed, scutiform spinelets or papillæ. On the non-prominent adambulacral plates there is a similar group of scutiform papillæ on the outer part of the plate, and two or three similar appendages advance towards the furrow margin of the plate.

The actinostome is rather small and depressed. The mouth-plates trend upward into the buccal cavity.

The madreporiform body is very difficult to find and almost hidden by scales. The few striæ which may be seen are coarse.

The anal aperture, which is inconspicuous, is excentric, and lies outside the dorso-central plate and its circle of scales. The orifice is closed by three or four scales, scarcely distinguishable from the neighbouring scales.

The ambulacral tube-feet are crowded and form four alternating rows. They have a more or less button-like fleshy termination.

The terminal plate is small, smooth, and rounded anteriorly.

I have failed to detect the presence of pedicellariæ of any kind in this starfish.

Colour in alcohol, a light brownish yellow, excepting the smooth naked primary plates and median radial plates, which are white. The elongate spines of the marginal and actinal intermediate plates are white.

Locality.—Station 204. Off Tablas Island, Philippine group. November 2, 1874. Lat. 12° 43′ 0″ N., long. 122° 9′ 0″ E. Depth 100 fathoms. Green mud. Surface temperature 84°·0 Fahr.

Remarks.—Pholidaster squamatus is nearly related to *Pholidaster distinctus*, and the differences are discussed in the description of that species. These two remarkable forms are altogether unlike any other starfish with which I am acquainted.

2. *Pholidaster distinctus*, n. sp. (Pl. LXVII. fig. 7).

Rays five. R = 70 mm.; $r = 7{\cdot}25$ mm. $R > 9{\cdot}5\ r$. Breadth of a ray near the base, 7·25 mm.

Although this form is very nearly allied to *Pholidaster squamatus*, it appears to be a well-marked species. Its general habit, however, accords so closely with the preceding description that it seems to me more satisfactory to give a comparative review of the points wherein the two differ than a long description, which would be in a large measure a repetition of what has gone before.

The general form of the rays is the same, but in *Pholidaster distinctus* the disk is not higher than the base of the rays and is not convex. The median radial series of plates are distinctly convex, forming a broad slightly elevated band along the ray. The breadth of the median radial series is rather greater than in *Pholidaster squamatus*. The appearance of the disk is very different in consequence of the under-basals being exposed, and nearly as large as the primary radials; the median radial series of plates thus extending uninterruptedly from the dorso-central plate to the extremity. Smooth basal plates, margined by scales, are also present. The supero-marginal plates are in like manner naked and margined only by a single series of scales on their outer margin. This produces a very strongly marked superficial difference between the two forms, as the supero-marginal plates in *Pholidaster squamatus* are entirely masked by scales. The lateral spines and the large single spines on the actinal intermediate plates are relatively smaller in *Pholidaster distinctus* than in *Pholidaster squamatus*. Furthermore, there are not more than two longitudinal series of spines borne on the actinal intermediate plates in the former, whereas there are three in the latter, and one of these is often small and aborted on the outer part of the ray.

In the armature of the adambulacral plates the spinelets on the ridge of the prominent

adambulacral plates behind the first pair are more frequently in single series than in oblique pairs, forming a slightly oblique line on the ridge much more distinctly than in *Pholidaster squamatus*. The spinelets are also rather shorter than in that species, and show a slight tendency to be curved.

Colour in alcohol, a bleached greyish white, with a tendency to a light brownish shade.

Locality.—Station 192. In the Banda Sea, between the Ki Islands and the Banda Islands. September 26, 1874. Lat. 5° 49′ 15″ S., long. 132° 14′ 15″ E. Depth 140 fathoms. Blue mud. Surface temperature 82°·0 Fahr.

Family Stichasteridæ, Perrier, 1885.

The general structure of the small group of forms now classified together fully warrants, in my opinion, their recognition as an independent family. The skeleton of *Stichaster* differs so essentially from that of the Asteriidæ that I venture to think the justice of the step taken by Perrier[1] will not be disputed. I differ, however, from Perrier, in that I exclude from the Stichasteridæ the genus *Zoroaster*, which, with its allies, I have placed in a separate family. The Stichasteridæ in many respects occupy an intermediate position between the Zoroasteridæ and the Asteriidæ.

Of the two new genera which I have ranked in this family, *Neomorphaster* and *Tarsaster*, the former is especially striking for the approach it presents to the Zoroasteridæ.

The family comprises the genera *Stichaster*, *Neomorphaster*, and *Tarsaster*.

Genus *Stichaster*, Müller and Troschel.

Stichaster, Müller and Troschel, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, 1840, April, p. 102.
Tonia, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 180.
Cœlasterias, Verrill, Trans. Conn. Acad. Arts and Sci. 1871 (1867), vol. i. part 2, p. 247.
Stephanasterias, Verrill, Bull. Essex Institute, 1872 (1871), vol. iii. p. 5 (non *Stephanaster*, Ayres, 1851).

So far as at present known this genus appears to be confined to the temperate and frigid zones; and most of the species are probably limited bathymetrically to the Littoral zone, only two occurring in the Continental zone and one in the Abyssal zone.

Chorology of the Genus Stichaster.

a. Geographical distribution:—

Atlantic: Six species between the parallels of 80° N. and 60° S.

**Stichaster albulus*, from Greenland, the northern coasts of the American continent, Iceland, and Spitzbergen. **Stichaster roseus*, from the coasts of Britain and Norway. *Stichaster arcticus*, off

[1] *Ann. Sci. Nat.* (Zool.), 1885, t. xix. Art. No. 8, p. 15.

the Lofoten Islands. *Stichaster talismani*, off the Canary Islands and Azores. **Stichaster felipes*, off the Cape of Good Hope. *Stichaster nutrix*, from South Georgia.

Pacific : Four species between the parallels of 10° and 55° S.

**Stichaster aurantiacus*, off the coasts of Chili and Peru. **Stichaster polygrammus*, off the western coast of South America, near the entrance to the Strait of Magellan. *Stichaster australis*, from New Zealand. **Stichaster polyplax*, from South Australia.

β. *Bathymetrical range:* 2 to 782 fathoms.

Stichaster albulus extends from 3 to 192 fathoms, passing into the Continental zone. *Stichaster roseus* occurs in from 2 to 50 fathoms. *Stichaster polyplax* in 38 to 40 fathoms. *Stichaster felipes* in 150 fathoms. *Stichaster polygrammus* is found in the Continental zone at a depth of 245 fathoms. *Stichaster talismani* inhabits the Abyssal zone, its range of depth extending from 517 to 782 fathoms.

γ. *Nature of the Sea-bottom:* Nearly all the species of which the habitat is recorded have been found on a hard bottom. *Stichaster albulus*, on rocks, stony ground, and branching Nullipores ; *Stichaster roseus* on sandy clay ; *Stichaster aurantiacus* on rocks ; *Stichaster polyplax* on sand and shells ; *Stichaster felipes* on Green sand ; *Stichaster polygrammus* on Blue mud.

The species collected by the Challenger Expedition are indicated in the above list by an asterisk.

Chorological Synopsis of the Species herein mentioned.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Stichaster albulus	Atlantic.	3 to 192	Rocks, and hard ground.
Stichaster aurantiacus	Pacific.	Shallow water.	Rocks.
Stichaster felipes	Atlantic.	150	Green sand.
Stichaster polyplax	Pacific.	38 to 40	Sand and shells.
Stichaster roseus	Atlantic.	2 to 50	Sandy clay.
Stichaster polygrammus	Pacific.	245	Blue mud.

1. *Stichaster aurantiacus* (Meyen), Verrill.

Asterias aurantiaca, Meyen, 1834, Reise um die Erde, Thl. i. p. 222.

Stichaster striatus, Müller and Troschel, 1840, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, April, p. 102.

Tonia atlantica, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 180.
Asteracanthion aurantiacus, Müller and Troschel, 1842, System der Asteriden, p. 21.
Stichaster aurantiacus, Verrill, 1871 (1867), Trans. Conn. Acad. Arts and Sci., vol. i. part 2, p. 293.

Locality.—Valparaiso. November 1875. On the shore.

2. *Stichaster roseus* (O. F. Müller), Sars.

Asterias rosea, O. F. Müller, 1788, Zool. Dan., p. 35, tab. lxvii.
Linkia rosea, Thompson, 1840, Ann. Nat. Hist., vol. v. p. 245.
Cribella rosea, Forbes, 1841, Hist. Brit. Starfishes, p. 106.
Asteracanthion roseus (*pars*), Müller and Troschel, 1842, System der Asteriden, p. 17.
Stichaster roseus, Sars, 1861, Oversigt af Norges Echinodermer, Christiania, p. 86.

A number of examples of this species were collected during the "Porcupine" Expedition, but no record is given of the Station or depth at which they were obtained.

3. *Stichaster albulus* (Stimpson), Verrill.

Asteracanthion roseus (*pars*), Müller and Troschel, 1842, System der Asteriden, p. 17.
Asteracanthion albulus, Stimpson, 1853, Syn. Mar. Invert. Grand Manan, p. 14.
Asteracanthion problema, Steenstrup, 1855, Videnskab. Medd. naturh. Foren. i Kjøbenhavn f. 1854, p. 240.
Asterias albula, Stimpson, 1863, Proc. Acad. Nat. Sci. Philadelphia, p. 142.
Stichaster albulus, Verrill, 1866, Proc. Boston Soc. Nat. Hist., vol. x. p. 351.
Stephanasterias albula, Verrill 1872 (1871), Bull. Essex Institute, vol. iii. p. 5.

Locality.—Station 49. South of Halifax, Nova Scotia. May 20, 1873. Lat. 43° 3′ 0″ N., long. 63° 39′ 0″ W. Depth 85 fathoms. Gravel, stones. Bottom temperature 35°·5 Fahr.; surface temperature 40°·5 Fahr.

4. *Stichaster polyplax*, Müller and Troschel, sp.

Asteracanthion polyplax, Müller and Troschel, 1844, Archiv f. Naturgesch., Jahrg. x., Bd. i., p. 178.
Asterias polyplax, Perrier, 1875, Révis. Stell. Mus., p. 63 (Archives de Zool. expér., t. iv. p. 327).

Locality.—Station 162. Off East Moncœur Island, Bass Strait. April 2, 1874. Lat. 39° 10′ 30″ S., long. 146° 37′ 0″ E. Depth 38 to 40 fathoms. Sand and shells. Surface temperature 63°·2 Fahr.

Remarks.—The structure of this form necessitates, in my opinion, its removal from the genus *Asterias;* and on these grounds I have classed it with *Stichaster*, although I am inclined to think that when more is known of the anatomy of *Stichaster*, the establishment of a subgenus, if not actually a distinct genus, may be required for the reception of *Asteracanthion polyplax*, in which probably some other forms now placed under *Asterias* may also ultimately be included.

5. *Stichaster felipes*, n. sp. (Pl. CI. figs. 1 and 2; Pl. CIII. figs. 7 and 8).

Rays five. R = 66 mm.; r = 10 to 11 mm. R > 6 r. Breadth of a ray near the base, 12 to 15 mm.

Rays elongate, rather broad at the base, and tapering gradually therefrom up to the extremity, their form being more or less cylindrical, slightly flattened. The disk is slightly convex in the region covered by the primary apical plates; and there is a rather deep and broad depression in each interradium external to this area, from which a depressed sulcus proceeds up to the summit of the interbrachial arc. The interbrachial arcs are acute.

The abactinal area of the disk is occupied on fully the central half by large permanent primary apical plates. All the plates along the rays are arranged in regular longitudinal series. The abactinal plates may be defined as follows: a median series of large, broad plates, succeeded on each side by an intermediate series of smaller plates, and a lateral series of large plates broader than those of the median series. Then follow two series of smaller marginal plates, which stand wholly in the lateral wall of the ray, the plates of the superior series being larger than those of the companion series. Between these and the adambulacral plates intervene two, or at the base of the ray perhaps three, series of intermediate plates.

The abactinal and marginal plates bear short, robust, clavate, obtuse, equal spinelets, which viewed from above appear little more than large hemispherical granules. On the plates of the median series there may be either a double line of spinelets, the lines more or less unequal and irregular, or an angulated line with a few additional spinelets within the angle, the number varying from five to nine. On the small intermediate plates are not more than two or three in a group. On the broad lateral plates is a single line of six or seven spinelets, or an angulated and supplemented line as in the median series. About three spines are present on the supero-marginal plates, and seldom more than two (sometimes three and sometimes one) on the infero-marginal series. All these spinelets are well spaced. All the plates are covered with thick membrane, and on this are attached numerous isolated, well spaced, forcipiform pedicellariæ, which at first sight have the appearance of smaller granules accompanying the larger granules (the spines above described). Large papular areas occur at the angles of the plates, which fall in regular longitudinal lines along the ray. There are from three to five papulæ in each. Close to the margin of the papular area may be one or more very large forficiform pedicellariæ. These are of remarkable form, and resemble two hands clasped together when the fingers are bent at right angles and interlocked. The jaws of the pedicellariæ are longer than the spines on the plates and also broader. Seen in some aspects their outline suggests fancifully the shape of a cat's paw with the claws exposed. These large pedicellariæ are numerous in the interbrachial arc.

The adambulacral plates are small, and their armature consists of two short, cylindrical, obtuse, equal spinelets, which radiate apart and normally form two regular longi-

tudinal rows, one directed over the furrow and the other outward. Occasionally one of these spinelets may be replaced or accompanied by one of the large cat's-paw-like forficiform pedicellariæ.

The plates of the inner row of actinal intermediate plates, adjacent to the adambulacral plates, bear one short, robust, obtuse spinelet, rather larger than the spinelets on the abactinal plates; and the plates of the outer row (at least on more than the inner half of the ray) bear two similar spinelets, placed side by side and rather oblique. On the intermediate row, when this is present, there may be one spinelet like those on the inner row, or occasionally near the base of the ray two spinelets like those on the outer row of plates. On the membrane which covers these plates are numerous, but distinctly spaced, sessile, forcipiform pedicellariæ and occasionally one of the large cat's-paw-shaped forficiform pedicellariæ.

In the armature of the mouth-plates there are several of these large pedicellariæ, and in the median actinal interradial area reaching from the mouth-plates to the margin are several large pedicellariæ of the same pattern, wide apart; and no other appendages of any kind are present on the membrane in this region.

The madreporiform body, which is small, occupies the central half of one of the basal plates, and its circumference is surrounded by irregularly placed spinelets. It is situated nearer the centre than midway between that point and the margin.

The anal aperture is distinct.

The ambulacral tube-feet are crowded, and form four rows.

Colour in alcohol, a brownish ashy grey, or a slightly orange yellow.

Localities.—Station 142. South of the Cape of Good Hope. December 18, 1873. Lat. 35° 4′ 0″ S., long. 18° 37′ 0″ E. Depth 150 fathoms. Green sand. Bottom temperature 47°·0 Fahr.; surface temperature 65°·5 Fahr.

Simon's Bay, Cape of Good Hope. Depth and conditions not recorded.

Remarks.—This species presents some superficial resemblance to *Stichaster aurantiacus*, but is readily distinguished from that form and all the other members of the genus by the character of the spinulation of the plates and by the presence of the remarkably large and strangely shaped forficiform pedicellariæ.

A slight difference may be noticed in the spinulation of the marginal plates in the examples from Simon's Bay as compared with one from Station 142, the spinelets being more numerous and more grouped in the former. The difference is so slight that I do not consider further remark necessary. The example from Station 142 has also rather more robust rays.

6. *Stichaster polygrammus*, n. sp. (Pl. C. figs. 1–3; Pl. CIII. figs. 5 and 6).

Rays five. R = 79 mm.; r = 10 mm. R < 8 r. Breadth of a ray at the base, 12·5 mm.; breadth about midway between the base and the extremity, 10 mm.

Rays elongate, subcylindrical, broad at the base, and tapering gradually to a pointed extremity. Disk small and somewhat inflated, with deep channels in the median interradial lines, the rays appearing to be crushed together at the base. Interbrachial arcs acute.

The abactinal and lateral areas are covered with narrow plates transversely disposed, which are arranged in longitudinal rows along the rays. The median radial series, the supero-marginal, and the infero-marginal (or actinal) series, form regular series. Between the supero-marginal and the median radial series are two series of smaller plates which are not so regular. Each of the plates of the median series bears a single lineal series of five to seven low, truncate, granule-like spinelets, which follows the line of the plate, and is consequently transverse in position in relation to the ray. The spinelets are all uniform, equidistantly spaced, and the median one is slightly removed adcentrally from the line which the others form. The plates of the two series of small intermediate plates may each bear two or three similar granules or spinelets, which are also disposed in transverse lines. These two series are not very distinctly divided from each other, but are clearly separated from the broad median radial series on the one side, and the equally broad supero-marginal series on the other by narrow well-defined bands. The plates, which I consider to be the representatives of supero-marginals, are entirely situated in the lateral wall of the ray; they are equal in height to the breadth of the median radial series, and each plate bears a single line of five or six uniform, equally spaced, granule-like spinelets, the two lowest sometimes standing slightly oblique, and giving the appearance of a faint angle in the line. All the spinelets on the seven series of plates above described are uniform and equally spaced; and their regular transversely lineal disposition on the rays gives a remarkable and characteristic appearance to the species. The interspaces between the plates are occupied by small and remarkably uniform papulæ. A few widely spaced, isolated, forcipiform pedicellariæ are present among the papulæ and on the plates.

The armature of the actinal series of plates adjacent to the adambulacral plates, which I consider to be the representatives of infero-marginal plates, consists of four or occasionally five short, robust, slightly compressed, truncate or obtusely tipped spinelets. The uppermost spinelet is rather smaller than, and somewhat isolated from, the others, which are arranged in a slightly oblique transverse series; when four are present between the uppermost spinelet and the adambulacral plates, they may be arranged in two slightly oblique pairs. Near the small upper spinelet are two or three forcipiform pedicellariæ similar to those on the abactinal and lateral areas; and between the transverse series of larger spinelets, near the adambulacral plates, may be occasionally a large isolated forficiform pedicellaria, with broad, expanded, denticulate, interlocking jaws, fancifully resembling a cat's paw, and recalling by their shape the forficiform pedicellariæ in *Stichaster felipes*.

The adambulacral plates abut on the infero-marginal plates, and their armature consists

of two moderately elongate, robust, cylindrical, slightly tapering, obtusely tipped, equal spinelets, which stand close together one behind the other. At the base of the innermost spine, on the margin of the furrow, are occasional medium-sized forficiform pedicellariæ, and near the mouth some of these are of the cat's-paw form mentioned above.

The madreporiform body, which is large and conspicuous, is situated near the margin; its surface is slightly convex and marked with numerous fine, much convoluted striations, and its circumference is surrounded by a close circlet of about twenty-two short papilliform spinelets doubled in places.

The ambulacral tube-feet, which are crowded, are disposed in a quadriserial arrangement, and have a small, fleshy, centrally invaginated terminal disk.

Colour in alcohol, a bleached greyish white.

Locality.—Station 311. Off the western coast of South America, near the entrance to the Strait of Magellan, opposite Port Churruca. January 11, 1876. Lat. 52° 45′ 30″ S., long. 73° 46′ 0″ W. Depth 245 fathoms. Blue mud. Bottom temperature 46°·0 Fahr.; surface temperature 50°·0 Fahr.

Remarks.—This remarkably handsome form is readily distinguished from all other species by the regular uniserial transverse lines of well-spaced, uniform, granule-like spinelets borne on the plates, by its general form and structure, and by the armature of the actinal or infero-marginal plates. Possibly the starfish described by Philippi[1] under the name of *Asteracanthion fulvum* may be allied to and congeneric with *Stichaster polygrammus*, but it is clearly specifically distinct, as shown by the radial proportions, and by the statement that the series of plates most remote from the median radial series bear only two spines. In *Stichaster polygrammus* five or six are regularly present; and the pedicellariæ could scarcely be described as numerous or small, as is the case in *Asteracanthion fulvum*. Unfortunately no types of the Chilian starfishes described by Philippi are available in any of the European collections, so far as I am aware, and no figures accompany the otherwise excellent descriptions.

Genus *Neomorphaster*, n. gen.

Glyptaster, Sladen in Narr. Chall. Exp., 1885, vol. i. p. 612 (non *Glyptaster*, Hall, 1852).

Disk small. Rays broad at the base, comparatively long, subrigid and tapering. Interbrachial arcs subacute.

Abactinal area of the disk occupied by largely developed permanent primary apical plates, the dorso-central, basals, and radials being conspicuous; under-basals are also present.

Rays covered with large, subhexagonal, slightly convex, imbricating plates, arranged in perfectly regular longitudinal lines; and bearing a few large, widely-spaced, semi-

[1] *Archiv f. Naturgesch.*, 1870, Jahrg. xxxvi., Bd. i. p. 270.

circular, translucent granules. Three abactinal and two marginal series of plates present. Large papulæ occur between the series of plates, one opposite each suture, and these form regular longitudinal lines between the rows of plates.

Adambulacral plates small. Armature consisting of two spines, which radiate apart and form two regular longitudinal series, one directed towards the furrow, the other outward.

A single series of actinal intermediate plates present between the infero-marginal and adambulacral plates, which bear two or rarely three spines, placed side by side, and forming a longitudinal series along the ray. A few additional plates similarly armed are present at the base of the ray in large specimens.

Madreporiform body small, circular, occupying the centre of a primary basal plate. Striæ coarse and regular in arrangement.

Anal aperture distinct; excentric in position.

Small forcipiform pedicellariæ present on the lateral regions of the rays and also, but less frequently, on the abactinal areas in the neighbourhood of the papulæ.

Ambulacral tube-feet, with a fleshy terminal disk centrally invaginated, forming four alternating rows along the greater part of the ray; at the extremity the arrangement is in simple pairs.

Remarks.—This exceedingly handsome form appears to occupy an intermediate position between *Zoroaster* and *Stichaster*. So far as known it is limited to the northern area of the Atlantic.

Chorology of the Genus Neomorphaster.

a. Geographical distribution:—

Atlantic: One species between the parallels of 35° and 45° N.
Neomorphaster eustichus, off the Azores.

β. Bathymetrical range: 900 to 1000 fathoms.

γ. Nature of the Sea-bottom: Pteropod ooze.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Neomorphaster eustichus . .	Atlantic.	900 to 1000.	Pteropod ooze.

1. *Neomorphaster eustichus*, n. sp. (Pl. LXVI. figs. 3 and 4 ; Pl. LXVIII. figs. 9 and 10).

Rays five. R = 49 mm. ; $r = 11$ mm. $R < 4{\cdot}5\ r$. Breadth of a ray at the base, 10 mm.

Rays high and broad at the base, tapering gradually to the extremity ; roundly arched abactinally ; plane actinally. Interbrachial arcs subacute, with a tendency to be rounded. Actinal surface plane, but deeply depressed round the mouth.

The disk is high and a central area occupying more than half the abactinal surface is distinctly depressed, the plates round its margin being on a higher level. This area contains the primary apical plates, which are disposed in the following manner. The centre is occupied by the dorso-central plate, external to this are five small under-basals, which are succeeded by five large basal plates, slightly larger than the dorso-central ; and between these and the under-basals are large isolated papulæ. Outside the cycle of basal plates are five large primary radial plates, nearly as large as the basals, each of which is separated from its accompanying under-basal by a large papula. On the outer side of the basal plates are two small plates side by side, and these with the primary radials complete the outermost cycle of the depressed area.

The rays are covered with large, subhexagonal, slightly convex plates which imbricate on one another and are arranged in perfectly regular longitudinal lines, the plates diminishing regularly as they proceed outward. The adjacent plates of the different series are equal in length and consequently form transverse series. The plates of the median radial series are the largest. The plates of the next series are smaller ; and the succeeding ones, which represent the supero-marginal plates, are nearly as large as the median series. The infero-marginal plates, which stand vertical in the lateral wall of the ray, are nearly equal to the superior series.

All the plates of the seven longitudinal series above-mentioned and the abactinal plates of the disk bear a few, large, widely spaced, semicircular, translucent granules.

Along the rays a large papula stands opposite the suture between each plate, and these form regular longitudinal lines separating the rows of plates.

Small forcipiform pedicellariæ are present on the lateral regions of the ray and also, but less frequently, on the abactinal area, in the neighbourhood of the papulæ.

The adambulacral plates are small, and their armature consists of two short, thick, robust, obtuse, equal spines, which radiate apart, one directed toward the furrow, the other outward, and form two regular longitudinal series.

Between the adambulacral and the infero-marginal plates is a series of elongate actinal intermediate plates which bear two or rarely three short, robust, obtuse, papilliform spinelets, placed side by side and forming a longitudinal series along the ray. This series of spinelets coincides with the more or less angular junction of the lateral and actinal surfaces of the ray, and leads at first sight to the inference that these are the representatives of lateral spines and that the series of plates are the infero-marginal plates. From their form and character, however, I do not consider that this is the true interpretation. At

the base of the ray a few additional plates similarly armed are present, but there do not appear to be more than four or five on each side of the median interradial line, and these form a short series parallel to the series already described. A few forcipiform pedicellariæ are present between the two series of spines.

The mouth-plates trend upward into the buccal cavity. The mouth-spines are similar in form and size to the spines on the adambulacral plates. The actinostome is rather small.

The madreporiform body is circular and occupies the centre of one of the basal plates. The striæ are coarse and arranged with great regularity, their general trend being centrifugal. The surface of the madreporiform body is slightly depressed and its margin is surrounded by a ring of granules.

The anal aperture is distinct and situated external to the dorso-central plate.

The ambulacral furrow is wide; and the tube-feet are closely crowded, forming four alternating rows until near the extremity—those on the outer fourth or fifth being in two simple rows. The tube-feet have a fleshy terminal disk with an invaginated centre.

The terminal plate is very small, and the granules upon it are elongate and papilliform in comparison to those on the adjacent plates.

Colour in alcohol, a bleached yellowish white.

Young Phase.—The smallest example amongst the series, which measures R = 13·5 mm., presents all the characters of the adult, and could not possibly be mistaken. It is to be noted, however, that the central area of the disk is not yet depressed. It is occupied by the large dorso-central and basal plates which are contingent, the under-basals being extremely small.

Localities.—Station 73. West of Fayal, Azores. June 30, 1873. Lat. 38° 30′ 0″ N., long. 31° 14′ 0″ W. Depth 1000 fathoms. Pteropod ooze. Bottom temperature 39°·4 Fahr.; surface temperature 69°·0 Fahr.

Station 76. Between the Islands of San Miguel and Pico, Azores. July 3, 1873. Lat. 38° 11′ 0″ N., long. 27° 9′ 0″ W. Depth 900 fathoms. Pteropod ooze. Bottom temperature 40°·0 Fahr.; surface temperature 70°·0 Fahr.

Genus *Tarsaster*, n. gen.

Rays elongate and subcylindrical as viewed from above. Disk small, with the junction of the rays indicated.

Abactinal area of the disk covered with large, permanent, primary apical plates. The rays covered with plates arranged in longitudinal series. The median series large, subimbricating. All the plates bearing short, co-ordinated spines (one to three in number in the type form). Plates covered with membrane bearing small isolated forcipiform pedicellariæ.

Supero-marginal plates large. Infero-marginal plates small, each with one small, compressed, horizontally disposed lateral spine, forming a regular longitudinal series at the ambital margin. Papulæ single, isolated, forming regular longitudinal lines between the plates.

Adambulacral plates small, contingent on the infero-marginal plates, not separated by papulæ. Adambulacral armature consisting of two equal spines which form two regular longitudinal rows.

Adambulacral tube-feet quadriserial in arrangement, with a fleshy, button-like, centrally invaginated terminal disk.

Madreporiform body small, occupying the median area of a basal plate near the margin.

Anal aperture present, excentric, external to the dorso-central plate.

Chorology of the Genus Tarsaster.

α. Geographical distribution:—

Pacific: One species between the parallels of 10° N. and 10° S.

Tarsaster stoichodes, off D'Entrecasteaux Reef, North of Admiralty Islands.

β. Bathymetrical range: 150 fathoms.

γ. Nature of the Sea-bottom: Coral mud.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Tarsaster stoichodes . .	Pacific.	150	Coral mud.

1. *Tarsaster stoichodes*, n. sp. (Pl. CIV. figs. 5–8).

Rays five. R = 53 mm.; $r = 5$ mm. $R > 10\ r$. Breadth of ray at the base, 6·75 mm.

Rays elongate, rather broad at the base in relation to the small disk, subcylindrical, convex, and arched abactinally, tapering from the base to the extremity, slightly constricted at the base. Disk very small, slightly convex, not higher than the base of the rays, the junction of the rays and disk being defined by a depression.

The abactinal area is beset with relatively large plates. The disk is covered with the primary apical plates, very few others being present. The plates upon the rays are

arranged in nearly regular longitudinal lines, the median radial series being larger than those adjacent on each side. Between the median series and the adambulacral plates on each side are three or four longitudinal series. The plates of the median radial series, which imbricate slightly, are more or less convex or crested transversely, and each bears three short, robust, cylindro-conical, obtusely tipped spinelets, the middle spinelets being placed rather more adcentrally than their lateral companions. The surface of the plate is covered with a close-fitting membrane, upon which are borne two or three small isolated forcipiform pedicellariæ. The plates of the most outward series are smaller, and bear normally one spinelet, but two may be present near the base of the ray, accompanied by one or two pedicellariæ. These are succeeded by a second series of small plates similarly armed with one spine, which alternate with the first series. Then follows a series of large broader plates at the edge of the ray, which represent the supero-marginal plates; each of these bears two or three spinelets, one spine being placed on the middle of the plate and another near the inferior end of the plate; the latter appears somewhat isolated, and is borne either on a prolongation of the plate or on a small intermediate plate, but I am unable to state which without dissection. Two or three isolated, small, forcipiform pedicellariæ occur on all the plates, and each of the series is separated by a longitudinal series of single isolated papulæ. Immediately external to the adambulacral plates, directly contingent and not separated by any papulæ, is a longitudinal series of small plates which represent the infero-marginal plates. Each of these bears a short, compressed, almond-shaped spinelet directed horizontally, forming a regular and conspicuous series of lateral spines standing at the extreme margin of the ray. One or two smaller pedicellariæ stand at the base of this spine on the superior side.

The adambulacral plates are very small. Their armature consists of two rather long, cylindrical, slightly compressed, obtuse spinelets, placed one behind the other, and forming two regular longitudinal rows. The outer series on the two sides of the ray are capable of entirely closing the furrow, masking the inner series of spinelets and the tube-feet.

The madreporiform body is small and circular, and appears to occupy the centre of a rather large plate, the covering membrane of which terminates abruptly at the margin of the madreporiform body. Its surface is grooved with comparatively few fine striations.

The larger apical plates on the disk bear two or three spines similar to those on the rays. A dorso-central, primary radials, basals, and under-basals, are distinguishable.

The anal aperture is excentric.

The ambulacral tube-feet, which are small and quadriserial in arrangement, have a fleshy, button-like, terminal disk.

Colour in alcohol, a light orange yellow.

Locality.—Station 219. Off D'Entrecasteaux Reef, North of the Admiralty Islands. March 10, 1875. Lat. 1° 54′ 0″ S., long. 146° 39′ 40″ E. Depth 150 fathoms. Coral mud. Surface temperature 84°·0 Fahr.

Family Solasteridæ, Perrier, 1884.

Notwithstanding the remarkable and in many respects archaic characters of the genera *Solaster* and *Crossaster*, they have until quite recently been classed with the Echinasteridæ. The discovery of deep-sea forms more or less closely allied has, however, excited closer attention, and in 1884 Perrier[1] established the family Solasteridæ, which comprised *Korethraster*, *Lophaster*, *Radiaster*, *Ctenaster*, *Solaster*, and *Crossaster*.

With this classification I fully concur, reserving only any expression of opinion as to the validity of the position of *Radiaster* and *Ctenaster* in this family, in consequence of my want of knowledge of the structure of the forms in question. I have on these grounds not included them in the following table.

I have added to the family two new genera, *Peribolaster* and *Rhipidaster*, the former approaching *Korethraster* in its affinities and the latter *Crossaster*.

Synopsis of the Genera included in the Family Solasteridæ.

A. Armature of the adambulacral plates in two series at right angles to each other . . . . . Solasterinæ.
  a. No actinal intermediate plates along the ray.
    a. With one series of well-developed marginal paxillæ.
      α. Abactinal structure reticulate. With widely spaced penicillate paxillæ. Papulæ numerous . . . . . *Crossaster*.
      β. Abactinal structure formed of stellate plates. With small closely crowded paxillæ. Papulæ single or few . . . *Solaster*.
    b. With two series of well-developed marginal paxillæ . . . . *Lophaster*.
  b. A continuous series of actinal intermediate plates along the ray, each of which bears an obliquely placed comb of spines . . . . . *Rhipidaster*.
B. Armature of the adambulacral plates forming with that of the actinal intermediate or infero-marginal plates a single transverse series . . Korethrasterinæ.
  a. Abactinal plates polygonal or rounded in outline. The spines composing the paxilliform tufts naked and free . . . . . *Korethraster*.
  b. Abactinal plates cruciform; forming wide meshes. The spines composing the paxilliform tufts in membranous sacs which are united together in the interior of the group . . . . . *Peribolaster*

Subfamily Solasterinæ, Sladen, 1888.

Genus *Crossaster*, Müller and Troschel.

Crossaster, Müller and Troschel, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, 1840 (April), p. 103.

The question of the validity of recognising *Crossaster*, *Solaster*, and *Lophaster*, as independent genera, has been so fully discussed by recent writers, that I do not propose to touch upon the subject further than to state that I maintain the three genera as

[1] *Nouv. Archives Mus. Hist. Nat.*, 1884, 2e Série, t. vi. p. 164.

distinct; and also that in my opinion the admirable illustrations given by Danielssen and Koren[1] in their memoir on the Asteroidea of the Norwegian North Atlantic Expedition support this view, notwithstanding the fact that the learned authors referred to considered that all the forms belonged to one genus.

Chorology of the Genus Crossaster.

α. *Geographical distribution:*—

Atlantic: Two species between the parallels of 40° N. and 82° N.

Crossaster affinis, in the North Atlantic between Norway, Spitzbergen, and Greenland; also in Bering Strait (*fide* Brandt).
**Crossaster papposus*, in the whole northern area of the Atlantic, extending up Smith Sound to Discovery Bay; from Assistance Bay, Newfoundland, Grand Manan, Massachusetts, Spitzbergen, Barent's Sea, Iceland, Nova Zembla, the Murman coast, the Scandinavian, British, and French coasts.

Southern Ocean: One species between the parallels of 35° S. and 50° S.

**Crossaster penicillatus*, from between Nightingale Island and Marion Island.

Pacific: One species between the parallels of 5° N. and 5° S.

Crossaster neptuni, from Ecuador.

β. *Bathymetrical range:* Shallow water to 640 fathoms.

Greatest range of one species: *Crossaster papposus*, shallow water to 640 fathoms.

Crossaster affinis is the only other species which extends into the Abyssal zone, its range being 70 to 634 fathoms.

γ. *Nature of the Sea-bottom:* *Crossaster papposus* is usually found on a hard bottom; also on Clay. *Crossaster affinis* frequents a Clay bottom, usually coarse and sandy, sometimes hard and stony. *Crossaster penicillatus* lives on Volcanic mud.

The species collected by the Challenger are indicated in the above list by an asterisk.

Asterias alboverrucosa, Brandt,[2] from Bering Strait, is probably a *Crossaster*, but as it appears to have been described from a drawing only, and as no subsequent author has referred to the type, I have not therefore felt justified in including it in the notice of the genus.

[1] Den Norske Nordhavs-Expedition, 1876–1878, Zoologi, xi. Asteroidea, 1884, tab. ix.

[2] *Act. Acad. St. Pétersb.* 1834, p. 271; Prodr. descr. anim. ab Mertensio obs., fasc. i. p. 71.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Crossaster affinis . . .	Atlantic (? Pacific: Bering Strait).	70 to 634	Clay (coarse, sandy, Blue); Stones.
Crossaster neptuni . . .	Pacific.	...	...
Crossaster papposus . . .	Atlantic.	Shallow water to 640	Hard ground, Clay.
Crossaster penicillatus . .	Southern Ocean.	140	Volcanic mud.

1. *Crossaster papposus* (Linck), Müller and Troschel.

Triskaidecactis papposus, Linck, 1733, De Stellis marinis, p. 43, tab. xxxii. No. 52, tab. xxxiv. No. 54.
Asterias helianthemoides, Pennant, 1777, British Zoology, vol. iv. p. 66, No. 72.
Asterias papposa, Fabricius, 1780, Fauna Grœnlandica, p. 369, No. 364.
Asterias (Solasterias) papposus, Blainville, 1834, Manuel d'Actinologie, p. 241.
Stellonia papposa, Agassiz, 1835, Prodr. Monog. Rad., Mém. Soc. Sci. Nat. Neuchatel, t. i. p. 192.
Solaster papposa, Forbes, 1839, Ast. Irish Sea, Mem. Wern. Soc., vol. viii. p. 121.
Crossaster papposus, Müller and Troschel, 1840 (April), Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, p. 103.
Solaster (Polyaster) papposa, Gray, 1840 (November), Ann. and Mag. Nat. Hist., vol. vi. p. 183.

Localities.—Station 48. South-west of Halifax, Nova Scotia. May 8, 1873. Lat. 43° 4′ 0″ N., long. 64° 5′ 0″ W. Depth 51 fathoms. Rock. Surface temperature 38°·0 Fahr.

"Porcupine" Expedition:

Station 52. In the Faeröe Channel. Lat. 60° 25′ N., long. 8° 10′ W. Depth 384 fathoms. Bottom temperature −0°·8 C.; surface temperature 11°·2 C.

Station 57. In the Faeröe Channel. Lat. 60° 14′ N., long. 6° 17′ W. Depth 632 fathoms. Bottom temperature −0°·8 C.; surface temperature 11°·1 C.

Station 64.[1] Between the Faeröe and Shetland Islands. Lat. 61° 21′ N., long. 3° 44′ W. Depth 640 fathoms. Bottom temperature −1°·1 C.; surface temperature 9°·3 C.

"Knight Errant" Expedition:

Station 3. In the Faeröe Channel. August 3 and 4, 1880. Lat. 59° 12′ N., long. 5° 57′ W. Depth 53 fathoms.

1*a*. *Crossaster papposus*, var. *septentrionalis*, Sladen.

Crossaster papposus, var. *septentrionalis*, Sladen, 1882, Proc. Roy. Soc. Edin., vol. xi. p. 704.

Rays ten, short, broad at the base, and sharply tapering. R = 35 mm., r = 18 mm. R < 2 r. Abactinal surface of the disk gibbous, sloping rather quickly at the base of the

[1] This occurrence is recorded in Sir Wyville Thomson's Depths of the Sea, but I have not seen any specimen from this station.

rays. Paxillæ small, numerous, closely crowded, with ten to twenty-one spinelets, which are more or less divergent from the pedicle. Fifteen to seventeen paxillæ may be counted in the median interradial line, and about ten across the base of the ray. Papulæ few, not more than one to three in a group.

Adambulacral armature consisting of: (1.) a furrow series of six spines on each plate near the mouth, and five on the more outward plates, the aboral spine smallest; (2.) a transverse series on the actinal surface of the plate composed of eight spines. The two spines nearest the furrow are placed more aborally than the rest, which gives the line of base of each transverse series an aboral curve at the furrow side. The middle spines are longest, the outermost smallest; all tapering to a fine point, robust at the base; no webbing apparent. Mouth-plates with robust mouth-spines, and a prominent series of nine or ten secondary or superficial spinelets, larger than the marginal mouth-spines. Interradial areas covered with small paxillæ, and rather crowded.

Remarks.—This variety, which was dredged in the Faeröe Channel, seemed to me worthy of being recognised by name on account of its constancy over a considerable area of distribution. The form is ten rayed, and accords in this and other particulars with a number of examples collected during the "Porcupine" cruise. The chief characters are persistent throughout the whole series of specimens I have examined, but several are present in an extreme degree in the Faeröe-Channel specimen.

On comparing with the above form a typical *Crossaster papposus* of the same diameter, it will be found that in the latter the rays, which are eleven to thirteen in number, are less tapering and relatively longer, the proportion being $R > 2{\cdot}5\ r$. The abactinal area of the disk is very little higher than the rays. The paxillæ are larger, fewer, more widely spaced, and bear a greater number of spinelets, usually about forty, which are arranged much more compactly and give the paxillæ a more rounded appearance,—often resembling that of a well-worn brush, the central spinelets being longest. The papulæ are more numerous, five to ten or more. The spinelets of the adambulacral armature are three in number in the inner or furrow series,—a fourth very minute one, placed aborally, being present near the mouth. The transverse combs consist of five spinelets, those near the furrow series the longest; line of base straight; webbing at the base more or less present. All the spinelets are more delicate in character than in the variety. Mouth-plates with delicate spines; secondary mouth-spines not more than two or three. Interradial areas quite naked, or with only one or two small paxillæ.

This variety conforms in several respects with the admirable description given by Danielssen and Koren[1] of the form they refer to the *Solaster affinis* of Brandt. The differences are, however, so marked that I cannot regard them as one and the same form; and in none of the specimens which I have examined from either the "Porcupine" or the

[1] *Nyt Mag. f. Naturvidensk.*, 1877, Bd. xxiii., 3, p. 57; Den Norske Nordhavs-Expedition, 1876–1878, Zoologi, xi. Asteroidea, 1884, p. 44, tab. viii. fig. 11, tab. ix. figs. 7, 8, 14.

"Knight Errant" dredgings, can I recognise an identity with the specimens described by the eminent Norwegian naturalists. Judging from the description above cited, it seems to me that the variety *septentrionalis* occupies an intermediate position between the typical form of *Crossaster papposus* and the *Solaster affinis* of Danielssen and Koren, and this circumstance previously led me[1] to express the opinion that the latter form might be a locational variety of the type of *Crossaster papposus*.

2. *Crossaster penicillatus*, n. sp. (Pl. LXX. fig. 5; Pl. LXXII. figs. 9 and 10).

Rays nine. R = 34 to 36 mm.; r = 12 mm. R < 3 r. Breadth of a ray near the base, 6 mm.

Rays narrow and rather attenuate, more or less arched abactinally and with a tendency to be carinated on the outer part. Disk slightly inflated. Interbrachial arcs rounded.

Abactinal area with small delicate plates forming a reticulated network with wide meshes, bearing small, rather widely spaced paxilliform tufts of spinelets, articulated on a tubercular base. The larger paxillæ on the disk and at the base of the rays have a crown of about ten or more spinelets, five or six being long and needle-like, the rest much shorter. From two to four large isolated papulæ occur in the meshes. No definite order of arrangement is discernible in the disposition of the paxillæ.

The marginal plates (the representatives of the infero-marginal series) are large and very widely spaced, and resemble greatly enlarged paxillæ. The base is thick and large, slightly compressed (the major axis being placed obliquely in relation to the axis of the ray) and bears a crown of about twelve to fifteen needle-like spinelets.

The armature of the adambulacral plates consists of two series of spinelets. (1.) A furrow series of four or five elongate spinelets united for a short distance at their base by a delicate membranous web, and forming a fan directed over the ambulacral furrow. (2.) A transverse lineal series of seven or eight long robust spines, longer than those of the furrow series, which may form either a straight or a slightly curved line on the actinal surface of the plate. These spinelets diminish in size at the outer end of the series, and are united for a short distance at their base by a delicate membranous web.

The mouth-plates are large and the united pair have a spade-shaped outline. Their armature consists of a marginal series of about nine elongate spinelets on each plate, the innermost one being larger and more robust than the others, which diminish a little in size as they recede from the mouth, and are rather smaller than the furrow series of spinelets on the adambulacral plates generally. They are united for a short distance at their base by a delicate membranous web, and form a slightly scoop-like marginal fringe. On the actinal surface of each plate are seven or eight elongate spinelets in a slightly curved lineal series, but sometimes irregular at the inner end of the series, where three spinelets may simulate a transverse series.

[1] Memoir of the Echinodermata of the Arctic Sea to the West of Greenland, London, 1881, p. 39.

The actinal interradial areas of the disk are covered with membrane, beneath which may be detected traces of small intermediate plates; and on only one or two of these is there a single short stumpy spine.

The madreporiform body is small, circular, convex, and situated about midway between the centre of the disk and the margin.

The ambulacral tube-feet have a large, fleshy, centrally invaginated terminal disk.

Colour in alcohol, a dirty brownish white.

Young Phase (?).—There is a very small example of a *Crossaster* from Station 145, which I am inclined to think may be the young of this species, but the specimen is too small for accurate determination, measuring only R = 7·5 mm. There are ten rays. In the armature of the adambulacral plates there are two or three spinelets in the furrow series, and four or five in the transverse series.

Localities.—Station 135c. Off Nightingale Island, Tristan da Cunha. October 17, 1873. Lat. 37° 25′ 30″ S., long. 12° 28′ 30″ W. Depth 110 fathoms. Surface temperature 54°·0 Fahr.

? Station 145. Off Marion Island. December 27, 1873. Lat. 46° 43′ 0″ S., long. 38° 4′ 30″ E. Depth 140 fathoms. Volcanic sand. Surface temperature 41°·0 Fahr.

Remarks.—This species resembles *Crossaster papposus* in habit, but is distinguished from that form by the number of rays, which are also narrower and more attenuate, by the widely spaced marginal combs, by the smaller paxillæ on the abactinal surface, which are more widely spaced and have fewer and more elongate spinelets in the crown, by the distinctly rounded interbrachial arcs, and by the skin-covered actinal interradial areas devoid of spinelets, as well as by the character of the armature of the adambulacral plates.

Genus *Rhipidaster*, n. gen.

Disk large, slightly convex, general form depressed, the habit resembling that of *Crossaster*. Rays (eight in the type form) robust and tapering.

Abactinal plates forming a wide-meshed reticulated network, bearing isolated paxilliform tufts of spinelets. Several large isolated papulæ are present in the meshes; and the membrane of the interspaces is beset with round, granule-like, fleshy papillæ round the margin of the papular orifice, and groups of the same are present on the membrane.

A series of marginal plates (? supero-marginal) which bear paxilliform tufts of rather elongate spines appressed to the ray, defines the abactinal area.

A single complete longitudinal series of actinal intermediate (or perhaps the representatives of infero-marginal) plates is present between the supero-marginal and adambulacral plates, each plate bearing a flat fan of spines appressed to the ray.

Adambulacral plates large. Armature consisting of two series of spines. (1.) The furrow series of seven or eight delicate spines partially united by a membranous web,

and forming a semicircular scoop-like fan. (2.) An obliquely placed flat comb of four spinelets, similar in size and character to those on the actinal intermediate plates and appressed to the ray.

Mouth-plates very large, with a prominent superficial actinal keel. Marginal armature forming three fans: an inner or buccal one common to the two plates, and a lateral one on each plate. On the median keel is a short lineal series of small conical spines on each plate.

Madreporiform body small, suboval, situated near the margin, marked with numerous very fine striæ.

Anal aperture excentric, inconspicuous.

No pedicellariæ of any kind are present.

Ambulacral tube-feet with a fleshy terminal disk, centrally invaginated, forming two regular series.

Remarks.—This large and well-marked form resembles *Crossaster* very closely when seen from above. It may be distinguished, however, at once by the structure of the actinal surface, the armature of the adambulacral plates, the presence and armature of the actinal intermediate plates, the character of the armature of the marginal plates, and the structure of the mouth-plates: a congeries of characters which furnish the generic features of *Rhipidaster*.

Chorology of the Genus Rhipidaster

α. Geographical distribution:—

Eastern Archipelago: One species between the parallels of 5° and 15° S.

Rhipidaster vannipes, in the Arafura Sea, between Cape York and Frederick Henry Island.

β. Bathymetrical range: 28 fathoms.

γ. Nature of the Sea-bottom: Green mud.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Rhipidaster vannipes . .	Eastern Archipelago.	28	Green mud.

1. *Rhipidaster vannipes*, n. sp. (Pl. LXIX. figs. 1–4).

Rays eight. R = 85 to 88 mm.; r = 27 mm. R < 3 r. Breadth of a ray at the base, about 18 mm.

Disk large, the general habit resembling that of *Crossaster papposus*. Rays rather

longer than the diameter of the disk, robust, broad at the base, and tapering to the extremity, slightly convex actinally. Interbrachial arcs acute.

Abactinal area with plates forming a reticulated network with wide meshes. The plates bear at widely spaced intervals tubercular eminences, on which are borne paxilliform tufts of four or five spinelets, which are robust at the base, tapering to a point, about 3 mm. in length, and usually all drawn together at the tip like a paint-brush when moistened and drawn to a point. No order of arrangement is discernible in the disposition of the paxillæ. Large isolated papulæ are present in the meshes, five, six, or even more, in those which are largest. These are remarkable from the fact that the margin of the orifice is beset with a ring of round, granule-like, fleshy papillæ, groups of which also occur on the intervening membrane, giving it a more or less verrucose appearance. The papulæ also appear to be delicately verrucose.

The marginal plates (? supero-marginal) form a regular and well-defined longitudinal line, and each bears a tuft of five or six spinelets rather longer and more robust than those on the abactinal paxillæ and appressed to the ray, the direction being nearly horizontal and outward. This series of plates is separated by a rather wide and well-defined space, occupied by smooth membrane, from another perfectly regular longitudinal series of plates situated midway between the supero-marginal plates and the adambulacral plates, and consequently midway on the actinal surface of the ray. These are either infero-marginal plates or actinal intermediate plates, but I am unable to say definitely which series they represent without mutilating the single example; I am inclined to rank them as intermediate plates. The plates in question are armed with a flat comb of four or five spinelets, similar to those on the marginal plates above described, more or less appressed to the ray, their direction being usually oblique and outward at an angle of about 45° to the line of the furrow.

The adambulacral plates are large and broader than long. Their armature consists of two series of spinelets. (1.) An inner or furrow series of seven or eight delicate, rather elongate, tapering spinelets, the outermost of the series rather smaller than the others, and all united for about half their length by a membranous web, forming a rather elongate, semicircular scoop or fan, the membrane extending uninterruptedly upon and covering the plate. (2.) Far back on the actinal surface of the plate is an oblique flat comb of four elongate, pointed spinelets, much larger and more robust than the furrow series, and similar to the spinelets on the actinal intermediate plates above described. They are appressed to the ray, their base line is oblique in position on the plate, and their direction is outward and at an angle of about 45° to the line of the furrow. The series of these actinal spines forms a regular longitudinal line along the ray. There are thus three regular, distinctly spaced, longitudinal lines of combs of spines visible on the actinal surface of the starfish.

The mouth-plates are very large, and have an elongate median eminence along the line

of suture. Their marginal armature has the appearance of forming three distinct fans, one at the inner extremity of the united pair of plates, and one on each plate laterally. The former is composed of the innermost five or six spines of each plate, which are robust, elongate, the one or two outer ones being smaller than the others, and they are united for about a third of their length by a membranous web, which extends uninterruptedly upon and covers the plate. The lateral combs are composed of about thirteen spinelets, which are shorter and very much more delicate than those in the buccal comb, and increase in size as they recede from the mouth, until near the outer extremity, when they again diminish in size. These spinelets are also webbed at the base like the buccal comb. On the flanks of the median keel there is a lineal series of four or five short conical spines on each plate, running parallel to the median suture, which diminish in size as they recede from the mouth. No other spines are borne on the mouth-plates. The actinostome is very large and widely open.

I have not been able to detect any supplementary intermediate plates in the interradial regions, in addition to those of the regular continuous longitudinal series above described.

The madreporiform body is rather small, transversely oval, slightly convex, and is situated near the margin. The striæ are remarkably fine and numerous.

The anal aperture is excentric and difficult to detect; two or three neighbouring paxillæ trend over the aperture, but are not modified in form in any way.

The ambulacral furrows are rather narrow in comparison to the size of the starfish. The tube-feet, which are arranged in two regular rows, have large, fleshy, centrally invaginated, terminal disks.

I have not detected the presence of pedicellariæ of any kind.

Colour in alcohol, a light yellowish brown, the paxillæ being a bleached ashy white.

Locality.—Station 188. In the Arafura Sea, between Cape York and Frederick Henry Island. September 10, 1874. Lat. 9° 59′ 0″ S., long. 139° 42′ 0″ E. Depth 28 fathoms. Green mud. Surface temperature 78°·5 Fahr.

Genus *Solaster*, Forbes.

Stellonia (*pars*), Agassiz, Mém. Soc. Sci. Nat. Neuchatel, 1835, t. i. p. 191.
Solaster, Forbes, Mem. Wern. Soc., 1839, vol. viii. p. 120.
Crossaster (*pars*), Müller and Troschel, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, 1840 (April), p. 103.
Solaster (subgenus *Endeca*), Gray, Ann. and Mag. Nat. Hist., 1840 (November), vol. vi. p. 183.

The genus *Solaster*, like *Crossaster* (with a single exception), was hitherto known only from the northern hemisphere. The new species obtained by the Challenger from the Pacific and Southern Oceans indicate a wide area of distribution. The bathymetrical range of *Solaster* is greater than that of the allied genus *Crossaster*. The discovery of

undoubted members of the genus at such widely separated localities, leads to the inference that future dredgings in the Pacific and Southern Oceans are likely to increase our knowledge greatly as to the distribution of the genus, as well as regarding the amount of morphological plasticity of which it is capable.

Chorology of the Genus Solaster

α. *Geographical distribution:—*

Atlantic: Four species between the parallels of 40° and 81° N.

Solaster abyssicola and *Solaster earllii*, off the coast of the United States of America. **Solaster endeca*, from the coasts of Greenland, North America, Norway, and Britain, the Faeröe Islands, Iceland, Spitzbergen, and extending to the Murman coast. It is also represented by a variety (*fide* Brandt), *Solaster endeca*, var. *decemradiata*, at Sitka. *Solaster glacialis*, between Norway and Beeren Island.

Southern Ocean: One species between the parallels of 45° and 55° S.

**Solaster subarcuatus*, between Kerguelen and Heard Island.

Pacific: Four species between the parallels of 60° N. and 60° S.

Solaster endeca, var. *decemradiata* (Brandt), from Sitka. **Solaster paxillatus*, off Japan. **Solaster torulatus*, from north of the Kermadec Islands. **Solaster regularis*, off the west coast of Patagonia.

β. *Bathymetrical range:* Shallow water to 1537 fathoms.

Greatest range of one species: *Solaster abyssicola*, 843 to 1537 fathoms. *Solaster torulatus* also extends into the Abyssal zone. *Solaster paxillatus* is confined to the Continental zone.

γ. *Nature of the Sea-bottom: Solaster endeca* occurs on Clay (fine or Blue), Stones or Sand. *Solaster glacialis* on Sandy clay. *Solaster regularis* on Blue mud. *Solaster subarcuatus* on Coarse gravel. *Solaster torulatus* on Volcanic mud. *Solaster paxillatus* on Green mud.

Solaster gracilis, Grube,[1] the type of which I have examined in Breslau, is a small eight-rayed *Luidia*, too young for specific determination, and is not a *Solaster* at all.

The species dredged by the Challenger are indicated in the foregoing list by an asterisk.

[1] *Jahres-Ber. Schles. Gesellsch f. vaterl. Cultur*, 1864, p. 52.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Solaster abyssicola	Atlantic.	843 to 1537	...
Solaster earllii	Atlantic.	...	...
Solaster endeca	Atlantic.	Shallow water to 150	Clay, Stones, and Sand.
Solaster endeca, var. *decemradiata* .	Pacific.	...	...
Solaster glacialis	Atlantic.	191	Sandy clay.
Solaster paxillatus	Pacific.	345	Green mud.
Solaster regularis	Pacific.	175	Blue mud.
Solaster subarcuatus . . .	Southern.	150	Coarse gravel.
Solaster torulatus	Pacific.	520	Volcanic mud.

1. *Solaster endeca* (Retzius), Forbes.

Asterias aspera, O. F. Müller, 1776, Zool. Dan. Prodr., p. 234, No. 2833.
Asterias endeca, Retzius, 1783, K. Svensk. Vet.-Akad. Handl. Bd. iv. 237.
Asterias (*Solasterias*) *endeca*, Blainville, 1834, Manuel d'Actinologie, p. 241.
Stellonia endeca, Agassiz, 1835, Mém. Soc. Sci. Nat. Neuchatel, t. i. p. 192.
Solaster endeca, Forbes, 1839, Mem. Wern. Soc. vol. viii. p. 121.
Solaster (*Endeca*) *endeca*, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 183.

Locality.—Station 48. South-west of Halifax, Nova Scotia. May 8, 1873. Lat. 43° 4′ 0″ N., long. 64° 5′ 0″ W. Depth 51 fathoms. Rock. Surface temperature 38°·0 Fahr.

2. *Solaster paxillatus*, n. sp. (Pl. LXXI. figs. 1–3; Pl. LXXII. figs. 1 and 2).

Rays nine. $R = 155$ mm.; $r = 50$ mm. $R > 3\ r$. Breadth of a ray at the base about 28 mm.

The rays are elongate, attenuate, and tapering, having a more or less subcylindrical appearance, the tumidity of the sides hiding the infero-marginal paxillæ altogether when the starfish is viewed from above. The disk is large, and its abactinal surface is capable of a considerable amount of inflation, as is also the basal portion of the rays. The actinal surface of the disk is convex and prominent round the mouth, that of the rays is plane. The interbrachial arcs are acute, but were probably slightly rounded when the abactinal area was inflated during life.

The abactinal surface is beset with small, low, uniform, paxilliform groups of spinelets, which consist of ten to twelve short equal spinelets, standing almost erect, compressed together and imbedded in a membranous mass, the tips of all the spinelets being level. The paxillæ, which are exceedingly numerous, are closely placed, and the general appearance of the abactinal surface to the naked eye at a short distance thereby produced is that of a coarsely granular surface. Large single papulæ occur in the interspaces. No definite order of arrangement is distinguishable in the paxillæ, except at the sides of the

rays, and especially on the outer half of the ray, where a transversely lineal disposition may be more or less clearly observed.

The supero-marginal plates are very small, only slightly larger than the neighbouring paxillæ of the abactinal area; and they alternate with the plates of the infero-marginal series. The infero-marginal plates are large, resembling massive paxillæ, the pedicle of which is metamorphosed into a broad compressed ridge, on which is borne a great number (forty to fifty) of short, robust, skin-covered spinelets. The infero-marginal paxillæ are tolerably well spaced, except in the interbrachial arc; and from fifty-eight to sixty-two may be counted between the median interradial line and the extremity. In the interbrachial arc and along the inner half of the ray, the infero-marginal paxillæ are entirely on the actinal surface, and they form a very conspicuous margin to the actinal interradial areas of the disk, some distance removed from the actual margin, as defined by the tumidity of the lateral wall of the rays.

The adambulacral plates are broad, and their armature consists of two series of spines. (1.) A furrow series of short, skin-covered, cylindrical, obtusely-tipped spinelets, five in number near the mouth, but four along the greater part of the ray, which become reduced to three on the outer third, and finally to two nearer the extremity. (2.) On the actinal surface of the plate is a transverse lineal series of five (occasionally four) large, robust, slightly tapering, but obtusely pointed, skin-covered spinelets, the innermost one of the series being placed out of the line and more aborally than the others. These spinelets decrease in number and size as they approach the extremity of the ray.

The mouth-plates are narrow and comparatively small for the size of the starfish. Their armature consists of a marginal series of about ten spinelets on each plate, the innermost two or perhaps three being longer than the rest, and there is a general decrease in size as they recede from the mouth. All are skin-covered, but no membranous web is developed. On the actinal surface of each plate is a lineal series of five large, robust, tapering, skin-covered spinelets, placed rather far back on the plate.

The actinal interradial areas are large and occupied by numerous intermediate plates, in which an indistinct arrangement parallel to the adambulacral plates may be made out. The intermediate plates bear tufts of four or five, and occasionally more, short, robust, tapering, skin-covered spines, which give a decidedly spinose character to the interradial areas.

The madreporiform body is hidden by paxillæ, and I have failed to detect its presence in the type specimen.

The ambulacral tube-feet have a large fleshy terminal disk.

Colour in alcohol, a dirty light brown. The ambulacral tube-feet and the buccal membrane are a dark purplish lead colour.

Locality.—Station 232. South of Yeddo, Japan. May 12, 1875. Lat. 35° 11′ 0″ N., long. 139° 28′ 0″ E. Depth 345 fathoms. Green mud. Bottom temperature 41°·1 Fahr.; surface temperature 64°·2 Fahr.

Young Phase.—I have referred a small example of *Solaster*, which measures R = 20 mm., from the same locality to this species. It is figured on Pl. LXX. Although at first sight this juvenile appears to differ considerably from the adult, I feel little doubt that the differences are only due to age. The number of rays is the same. The paxillæ are relatively larger and more distinctly spaced than in the adult. In the armature of the adambulacral plates there are only three spinelets in the furrow series on the plates near the mouth, and only two along the ray; the transverse lineal series on the actinal surface of the plates consists of three robust spinelets. The infero-marginal paxillæ form a conspicuous border on the actinal surface, similar to what has been observed in the adult, and the actinal interradial areas have a similar spinose character. The armature of the mouth-plates consists of a marginal series of eight spinelets, the innermost one being remarkable for its size and the capacious membranous sac with which it is invested. On the actinal surface of each plate is one large robust spinelet, and further back on the plate two or three smaller ones.

Remarks.—This species is very closely related to *Solaster endeca*, but may be distinguished by the form and character of the paxillæ, by the large actinal interradial areas, by the broad band of infero-marginal paxillæ, and by the character of the armature of the adambulacral plates.

3. *Solaster regularis*, n. sp. (Pl. LXX. fig. 1; Pl. LXXII. figs. 5 and 6).

Rays eight. R = 90 to 100 mm.; r = 20 mm. R = 4·5 to 5 r. Breadth of a ray at the base 14 mm.

The disk is high and convex. The rays are long, tapering, and attenuate towards the extremity; in the present condition of the specimen all are curled over on the abactinal surface. Interbrachial arcs acute.

The abactinal surface is beset with very short, rather broad, stumpy paxillæ, the crown composed of six to ten very short tapering spinelets, bi- or tri-dentate at the extremity, and their bases imbedded in a membranous mass, which envelops the whole basal part of the paxilla. The paxillæ are widely spaced upon the disk, and numerous large papulæ occupy the interspaces. Along the rays the paxillæ become much smaller and more numerous. No definite order of arrangement is discernible, although a slight tendency to lineal disposition may be made out along the sides of the rays.

There is a single series of conspicuous marginal plates, on which a thin elevated keel is developed, surmounted by a flattened comb of short robust spinelets, about ten to twenty in each, resembling enlarged compressed paxillæ, the long axis being placed at right angles to the median line of the ray. The combs are widely spaced, and about forty-two are present between the median interradial line and the extremity. I believe these to be the infero-marginal plates; and what I take to be the representatives of the

superior series are scarcely distinguishable from the paxillæ of the abactinal surface generally.

The adambulacral plates are large, and their armature consists of two series of spines. (1.) A furrow series of four or five short, flat, lanceolate spinelets, each in a membranous sac, which radiate apart and form a fan on the furrow margin of the plate. (2.) An actinal series of four or five large robust spines arranged in a straight line on the actinal surface of the plate at right angles to the furrow. These spinelets are thickly covered with membrane, and normally decrease in size as they recede from the furrow. The general surface of the plate is covered with membrane.

The mouth-plates are moderately large. Their armature consists of a marginal series of about nine spinelets on each plate, the innermost three on each plate being much larger than the succeeding ones, and enveloped in wide membranous sacs, which give them a compressed lanceolate appearance; the outer spinelets are much smaller, subconical or cylindrical in appearance, and diminish in size as they recede from the mouth. On the actinal surface of each plate is a lineal series, parallel to the median suture, of five robust sacculated spines which diminish in size as they recede from the mouth, the innermost being larger than any of the other mouth-spines.

In the actinal interradial areas of the disk there are three or four series of small actinal intermediate plates, which bear small, compact, well-defined paxilliform groups of four to six short equal spinelets; only the innermost of these series extends more than a little way beyond the base of the ray.

The madreporiform body is small, and is situated rather nearer the centre of the disk than midway between that point and the margin. Its surface is slightly convex, and the striations are fine.

The ambulacral tube-feet have large, fleshy, centrally-invaginated, terminal disks.

Colour in alcohol, a bleached greyish white.

Locality.—Station 308. South of Wellington Island, west coast of Patagonia. January 5, 1876. Lat. 50° 8′ 30″ S., long. 74° 41′ 0″ W. Depth 175 fathoms. Blue mud. Surface temperature 51°·7 Fahr.

Remarks.—*Solaster regularis* is characterised by the length of the rays, and by the comparatively large and widely-spaced paxillæ of the abactinal surface: characters which, taken in conjunction with the number of the rays and other minor points of detail, at once distinguish the species from its allies.

4. *Solaster subarcuatus*, n. sp. (Pl. LXX. fig. 2; Pl. LXXII. figs. 7 and 8).

Rays nine. R = 38 mm.; r = 12 mm. R > 3 r. Breadth of a ray at the base, about 7 mm. or rather less.

The rays are moderately elongate, and taper only slightly on the inner half of their length, but more rapidly on their outer half, remaining, however, rather broad even to

the extremity, which is obtusely pointed. The abactinal surface of the disk is slightly inflated, that of the rays arched, with a tendency towards a carinate appearance. The actinal surface is subplane. The interbrachial arcs are acute; and there is a sharply defined steep sulcus on the disk at the summit of each arc.

The abactinal surface is beset with small paxilliform groups of spinelets. The paxillæ are rather widely spaced, and the medium-sized ones near the base of the ray are composed of five or six very short spinelets, which are denticulate at the extremity but not tapering, and usually radiate only slightly apart. The paxillæ are arranged with more or less regularity in longitudinal lines along the rays, and single papulæ occur in the interspaces; occasionally two may be found together.

Of the marginal plates the superior series are small, and scarcely distinguishable from the paxillæ of the abactinal surface. The infero-marginal series resemble large paxillæ, with a broad and massive compressed pedicle, having the major axis placed at right angles to the median line of the ray, and surmounted by a crown of about ten to twelve spinelets, which are larger and more robust than the spinelets of the abactinal paxillæ. These marginal paxillæ are tolerably well spaced, and there are about twenty-six between the median interradial line and the extremity; those on the outer part of the ray becoming smaller in size, and the pedicle being reduced to a subtubercular eminence.

The adambulacral plates are short but broad, and their armature consists of two series of spines. (1.) A furrow series of short, skin-covered, slightly tapering spinelets, which are four in number near the mouth, and then three up to the middle of the ray; beyond this only two are present, and probably only one at the extremity. When four spines are present, the adoral and aboral spines of the series are generally smaller than the others. (2.) On the actinal surface of the plate is a transverse lineal series of four or five large, robust, cylindrical, obtusely-rounded and thickly skin-covered spinelets, which diminish in size as they proceed outward, and are reduced to three in number at the extremity of the ray.

The mouth-plates are large and elongate. Their armature consists of a marginal series of eight spinelets on each plate. The innermost three are larger than the others, which decrease slightly as they recede from the mouth. All are skin-covered, but there is no development of a definite membranous web. On the actinal surface of each plate is a lineal series of three or four skin-covered spinelets, which diminish in size as they recede from the mouth; the foremost three are long, robust at the base and tapering, but the fourth or outermost is usually very small.

The actinal interradial areas of the disk, which are narrow, are occupied by small intermediate plates bearing tufts of short, rather robust spinelets, about three to five in each.

The madreporiform body, which is very small and inconspicuous, is situated nearer the centre of the disk than midway between that point and the margin; the striations upon its surface are fine, and their direction is more or less centrifugal.

The ambulacral furrows are contracted; and the tube-feet, which have a crowded appearance, have a well-developed fleshy terminal disk.

Colour in alcohol, a bleached greyish white.

Locality.—Station 150. Between Kerguelen Island and Heard Island. February 2, 1874. Lat. 52° 4′ 0″ S., long. 71° 22′ 0″ E. Depth 150 fathoms. Coarse gravel. Bottom temperature 35°·2 Fahr.; surface temperature 37°·5 Fahr.

Remarks.—This species is nearly allied to *Solaster endeca*, of which it is perhaps the southern representative. *Solaster subarcuatus* is readily distinguished from the North Atlantic species by the form of the rays, by the larger and more widely spaced paxillæ, which are also more regularly arranged, and by the armature of the adambulacral plates.

5. *Solaster torulatus*, n. sp. (Pl. LXX. figs. 3 and 4; Pl. LXXII. figs. 3 and 4).

Rays eight. $R = 48$ mm.; $r = 17$ mm. $R < 3r$. Breadth of a ray at the base, 12 mm.

The rays are moderately elongate, broad at the base, slightly tumid on the inner half and then rapidly tapering to the extremity, the outer part being narrow and cylindrical. At the base of the rays on the disk there is a sharply defined sloping ravine or sulcus, continued from the summit of the interbrachial arc for a considerable distance on the disk, causing the disk to appear at first sight much smaller than it really is, and the rays to be crowded and pressed together at their bases. The abactinal surface of the disk is slightly convex. The actinal surface is plane. The interbrachial arcs are acute.

The abactinal surface is beset with very short, small, paxilliform groups of spinelets. The spinelets, of which there are eight to ten in each crown, are so small and compactly crowded that they are only distinguishable with a magnifying-glass; the groups or paxillæ appearing to the naked eye only like small, regular, uniform, semiglobular tubercles. These are well spaced apart and the interspace is occupied by a single papula. The paxillæ are arranged with great regularity, which may be resolved on careful examination into longitudinal and obliquely transverse lines.

The marginal plates (the representatives of the infero-marginal series) are quite on the actinal surface, to which they form the border, and are invisible when the starfish is viewed from above. They resemble large compressed paxillæ, the pedicle being large and massive, with the major axis at right angles to the median line of the ray, and surmounted by a crown of fifteen to twenty short compactly grouped spinelets. There are about thirty-five or thirty-six between the median interradial line and the extremity, those on the inner half of the ray being large and widely spaced, but they diminish in size as they proceed outward and become almost microscopic towards the extremity.

The paxillæ which represent the supero-marginal plates are small in comparison with the infero-marginal plates, and very little larger than the neighbouring paxillæ of the abactinal area. They alternate with the infero-marginal plates and consequently stand opposite the interspace between each of the large marginal paxillæ.

The adambulacral plates are large and their armature consists of two series of spines. (1.) A furrow series of five short, robust, rather broad, slightly compressed, skin-covered spinelets, united by a membranous web at their base, and forming a usually vertically disposed semicircular comb. (2.) On the actinal surface of the plate is a transverse lineal series of three, or occasionally four large, conical, skin-covered spinelets, which decrease in size as they recede from the furrow.

The mouth-plates are rather elongate, and with their armature have the appearance of an elongate pointed scoop. Their armature consists of a marginal series of ten spinelets on each plate. The innermost is rather longer than the others, the third and succeeding spinelets, which are subequal in length, are rather shorter than the second; all are united for fully two-thirds of their length by a membranous web. The innermost spinelet on each plate has rather an isolated appearance from the rest, and these two spinelets of the united pair of plates being close together give a characteristic appearance to the mouth-armature of this species. On the actinal surface of each plate is a curved series of five or six robust, conical, skin-covered spinelets, which diminish in size as they recede from the mouth.

In the actinal interradial areas of the disk there are three or four series of small actinal intermediate plates, which bear small paxilliform groups of four to six short, equal spinelets; the innermost series extends to nearly midway along the ray, but the others do not pass beyond the base of the ray.

The madreporiform body, which is small and inconspicuous, is situated rather nearer the centre of the disk than midway between that point and the margin. Its surface is not convex, the striations are rather coarse, and its margin is surrounded by five or six paxillæ rather larger than the neighbouring ones.

The anal aperture is distinct and subcentral. There is no modification in the size or character of the neighbouring paxillæ.

The ambulacral tube-feet are large, and have a fleshy, centrally-invaginated, terminal disk.

Colour in alcohol, a bleached yellowish white.

Locality.—Station 170. North of the Kermadec Islands. July 14, 1874. Lat. 29° 55′ 0″ S., long. 178° 14′ 0″ W. Depth 520 fathoms. Volcanic mud. Bottom temperature 43°·0 Fahr.; surface temperature 65°·0 Fahr.

Remarks.—This species is distinguished from all other forms by the shape of the rays, by the sloping ravine on the disk at their base, by the character of the abactinal paxillæ, and by the armature of the adambulacral plates and mouth-plates.

Genus *Lophaster*, Verrill.

Lophaster, Verrill, Amer. Journ. Sci. and Arts, 1878, 3rd ser. vol. xvi. p. 214.

Lophaster was hitherto known only from the North-Atlantic area. The Challenger obtained examples of a form which I consider referable to the genus from the South

Pacific, thus adding another example to the remarkable list of representative forms found in the temperate and sub-frigid zones of the Northern and Southern hemispheres respectively.

Chorology of the Genus Lophaster.

α. Geographical distribution:—

Atlantic: One[1] species between the parallels of 40° and 82° N.

Lophaster furcifer, off the coasts of Greenland and North America (extending as far north as Discovery Bay), in the Gulf of Maine and off Nova Scotia; off the coasts of Norway, Spitzbergen, and Nova Zembla.

Pacific: One species between the parallels of 40° and 55° S.

Lophaster stellans, off the western coast of South America.

β. Bathymetrical range: 30 to 1325 fathoms.

Greatest range of one species: *Lophaster stellans*, 40 to 1325 fathoms.

Both *Lophaster furcifer* and *Lophaster stellans* pass from the Littoral into the Abyssal zone.

γ. Nature of the Sea-bottom: Lophaster furcifer is found on Clay of various kinds, and on stones. *Lophaster stellans* on Blue mud.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Lophaster furcifer . .	Atlantic.	30 to 743	Clay and Stones.
Lophaster stellans . .	Pacific.	40 to 1325	Blue mud.

1. *Lophaster furcifer* (Düben and Koren), Verrill.

Chætaster borealis, Düben, 1844, Öfversigt K. Svensk. Vet.-Akad. Förhandl., p. 113.
Solaster furcifer, Düben and Koren, 1846, K. Svensk. Vet.-Akad. Handl., År 1844, p. 243, pl. vi. figs. 7–10.
Lophaster furcifer, Verrill, 1878, Amer. Journ. Sci. and Arts, ser. 3, vol. xvi. p. 214.

[1] A second species (*Lophaster radians*), from Barbados and Havanah, is mentioned by Perrier in his memoir on the Starfishes of the "Blake" Expedition (*Nouv. Archives Mus. Hist. Nat.*, 2e Série, t. vi. pp. 167, 169, 170), but no description is given. I am inclined to think that the generic name is due to a clerical error, and that the form referred to is that described under the name of *Korethraster radians* (*Bull. Mus. Comp. Zoöl.*, Harvard, 1881, vol. ix. No. 1, p. 12), but which seems to have been subsequently placed under the name of *Korethraster hispidus*, as the description is repeated verbatim (*Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi. p. 212), although no reference whatever is made to the original name.

Localities.—"Porcupine" Expedition:

Station 52, 1869. In the Faeröe Channel. Lat. 60° 25′ N., long. 8° 10′ W. Depth 384 fathoms. Bottom temperature −0°·8 C.; surface temperature 11°·2 C.

Station 55,[1] 1869. In the Faeröe Channel. Lat. 60° 4′ N., long. 6° 19′ W. Depth 605 fathoms. Bottom temperature −1°·2 C.; surface temperature 11°·4 C.

2. *Lophaster stellans*, n. sp. (Pl. LXXI. figs. 4 and 5; Pl. LXXII. figs. 11 and 12).

Rays five. R = 32 mm.; r = 11 mm. R < 3 r. Breadth of a ray at the base, 12 to 13 mm.

The rays are broad at the base, and taper gradually therefrom up to the extremity. The abactinal surface is convex over the disk and upon the rays, and tapers regularly to the extremity. The actinal surface is plane. The interbrachial arcs though wide are angular; and in consequence of the height and convexity of the disk, the declivity there at the summit of the arc is rapid.

The abactinal surface is beset with well-developed paxillæ, which are widely spaced and arranged with more or less regularity in longitudinal lines along the rays. The paxillæ have a thick, robust, skin-covered pedicle, and are surmounted by a crown of five to eight moderately robust subequal spinelets, with denticulate tips, usually shorter than the pedicle, which radiate widely apart, and, when well preserved, have a strongly marked stellate character; whence the name of the species. Numerous papulæ are present in the interspaces, usually in groups of four or five, or more.

The supero-marginal plates are well developed, and bear robust paxillæ with long pedicles, similar to those on the abactinal surface, excepting that the pedicles are longer and thicker. The infero-marginal plates bear still larger paxillæ, which are surmounted by a crown of rather more numerous spinelets. The rotundity of the pedicle is maintained, and there is no modification in the form of the paxillæ. The paxillæ are well spaced, and there are about eighteen between the median interradial line and the extremity.

The adambulacral plates are large, and are separated superficially by channels or wrinkles in the membrane with which the whole actinal surface is invested, passing obliquely from the furrow to the margin. Their armature consists of two series of spines. (1.) A furrow series of rather large but delicate, tapering, skin-covered spines, which radiate apart, and are partially united by web, forming a fan parallel to the furrow. Near the mouth five spinelets are present in each comb, but the number is successively reduced to four, three, and two, as they proceed along the ray, and probably only one spine is present at the extremity. (2.) On the actinal surface of the plate is a lineal transverse series of three (occasionally four near the mouth) large, robust, tapering, skin-

[1] This occurrence is recorded in Sir Wyville Thomson's Depths of the Sea, but I have not seen an example from this station.

covered spinelets, the innermost one of the series being sometimes out of line and more aboral in position than the rest.

The mouth-plates are large, spade-shaped, and prominent actinally. Their armature consists of a marginal series of nine rather short skin-covered spinelets, which decrease in size gradually as they recede from the mouth. The spinelets are united for a short distance above their base by a membranous web, and their posture has a slight trend downward, which causes the mouth-plates to assume a scoop-like appearance. On the actinal surface of each plate are about four erect, tapering, skin-covered spinelets, usually in a closely placed lineal series, but sometimes subject to irregularity, those nearest the mouth being largest. The fan on the furrow margin of the adambulacral plate next the mouth-plate is usually semicircularly curved and more prominent than the others, appearing to form a kind of supplementary appendage to the mouth-plate armature, which adds greatly to the ornate character of the actinal aspect of this species.

The actinal interradial areas are very small, and do not contain more than eight or ten small intermediate plates, probably fewer, and seven or eight of these bear small tufts of three or four short, tapering, skin-covered spinelets, the groups or tufts being widely spaced.

The madreporiform body, which is oval in outline and rather small, is situated about midway between the centre of the disk and the margin. Its surface is convex and is marked with rather coarse striæ.

The ambulacral tube-feet are large, and have well-developed fleshy terminal disks.

Colour in alcohol, a bleached ashy or yellowish white.

Localities.—Station 303. Off the Chonos Archipelago, western coast of South America. December 30, 1875. Lat. 45° 31′ 0″ S., long. 78° 9′ 0″ W. Depth 1325 fathoms. Blue mud. Bottom temperature 36°·0 Fahr.; surface temperature 54°·8 Fahr.

Station 308. South of Wellington Island, west coast of Patagonia. January 5, 1876. Lat. 50° 8′ 30″ S., long. 74° 41′ 0″ W. Depth 175 fathoms. Blue mud. Surface temperature 51°·7 Fahr.

Station 309. Off Puerto Bueno. January 8, 1876. Lat. 50° 56′ 0″ S., long. 74° 15′ 0″ W. Depth 40 fathoms. Blue mud. Bottom temperature 47°·0 Fahr.; surface temperature 50°·5 Fahr.

Remarks.—This species is readily distinguished from *Lophaster furcifer* by the general form, by the structure of the abactinal paxillæ, and by the character of the armature of the adambulacral plates.

Subfamily Korethrasterinæ, Sladen, 1888.

Genus *Korethraster*, Wyville Thomson.

Korethraster, Wyville Thomson, The Depths of the Sea, London, 1873, p. 120.

Form stellate. Rays moderately produced. Abactinal surface convex and more or less arched, meeting the actinal surface, which is plane, with an abrupt angle. Interbrachial arcs with a lunate outline.

Abactinal surface entirely covered with comparatively large, thin, squamous plates (oval or subcircular in the type form), which imbricate more or less upon one another. Each plate bears a compact fasciculus of elongate spinelets ankylosed together at their base, and articulated on a mammillate boss on the plate. No papulæ are present on the abactinal surface.[1] A well-defined channel traverses the median interradial line.

A single series of short but broad band-like plates (? infero-marginals) occupies the outer half of the actinal surface of the rays and defines the margin. Each plate bears on its free extremity in the margin a flattened, scoop-like, or flaring lateral spine.

Adambulacral plates short but broad, equal in length and correspondent to the infero-marginal plates; and appearing to form with these, at least on the inner half of the ray, a single transverse band passing from the ambulacral furrow to the margin,[2] the bands being separated by a distinct interspace of nearly equal breadth. Armature consisting of a single transverse series of rather robust, slightly flaring spines (four in number), rather widely spaced, one at each extremity, the innermost or furrow spine rather smaller and directed over the furrow, the outermost radiating outward; the series of these spines form longitudinal rows along the ray.

No actinal intermediate plates are present.

Mouth-plates with a prominent median keel resembling more or less closely the same structure in *Hymenaster*. Armature consisting of: (1.) A marginal series of four spines on each plate, the innermost largest and directed horizontally. (2.) On the actinal surface of each plate a large robust secondary mouth-spine, placed near the adoral end of the plate.

Madreporiform body small, circular, situated near the centre of the disk, marked with very coarse deep striæ.

[1] I believe that a single longitudinal series of papular orifices is present on the actinal surface on each side of the ambulacral furrow between the adambulacral plates, situated in the dark shade shown in the figure 9 on Pl. LXXX., but I am unable to make the statement definitely without dissection, which is of course undesirable in the unique specimen at my disposal.

[2] The junction of the plates is probably ankylosed, and is masked by the outermost spine of the adambulacral armature. This has probably led previous writers to speak of the actinal skeleton of *Korethraster* as formed of single band-like plates passing from the furrow to the margin. On the outer part of the ray near the extremity, the direction of the adambulacral and infero-marginal plates is not in the same line, and the two series of plates may be better distinguished there.

Anal aperture large, subcentral, surrounded by five or six subtubercular papillæ.

Ambulacral tube-feet, which are arranged in two rows, have a large, flat, fleshy terminal disk.

No pedicellariæ of any kind are present.

Remarks.—The character of the abactinal and actinal plating, the remarkable fasciculated spinulation of the abactinal plates, and the character of the armature of the adambulacral plates, together with the absence of papulæ on the abactinal surface, at once distinguish *Korethraster* from all other genera at present known. The morphological structure of the form has led Drs Danielssen and Koren[1] to place *Korethraster* in a distinct family, which they established for its reception (Korethrasteridæ), but although I do not feel prepared to oppose that course, I hesitate for the present about following it, and until more is known of the anatomy of this and allied forms, I prefer to leave the genus in the family Solasteridæ, as classified by Perrier, placing it, however, in a subfamily.

Several starfishes dredged during the "Blake" Expedition have been referred by Perrier to this genus, and were originally described[2] as representing two distinct species under the names of *Korethraster palmatus* and *Korethraster radians;* the latter was subsequently placed,[3] however, by its author under the name of *Korethraster hispidus*, but so far as I can judge from the description given, and no figure, I am inclined to think that this is certainly not the same as Wyville Thomson's *Korethraster hispidus;* and I feel very great doubt indeed as to whether either of the forms belong to the genus *Korethraster* at all. For the same reason, owing to insufficient description, I am reluctantly compelled to place a third form, described by Perrier[4] under the name of *Korethraster setosus*, in the same category of uncertainty. On these grounds I have not included the forms mentioned in my consideration of the chorology of the genus *Korethraster* given below.

Chorology of the Genus Korethraster.

a. Geographical distribution:—

Atlantic: One species between the parallels of 60° and 80° N.

Korethraster hispidus, in the Faeröe Channel, off the coast of Norway, and south of Franz-Josef Land.

[1] Den Norske Nordhavs-Expedition, 1876–1878, Zoologi, xi. Asteroidea, 1884, p. 99.

[2] *Bull. Mus. Comp. Zoöl.* Harvard, 1881, vol. ix. No. 1, p. 12.

[3] *Nouv. Archives Mus. Hist. Nat.*, 1884, 2e Série, t. vi. p. 212.

[4] Rapport sur les Travaux de la Commission chargée par M. le Ministre de l'Instruction publique d'etudier la Faune sous-marine dans les grandes profondeurs de la Méditerranée et de l'Océan Atlantique, par M. Alphonse Milne-Edwards, Membre de l'Institut (Extrait des *Archives des Missions scientifiques et littéraires.* Troisième série. Tome neuvième. Paris: 1882), p. 51.

β. *Bathymetrical range:* 101 to 632 fathoms.

γ. *Nature of the Sea-bottom:* Brown mud (Payer); Coarse granular clay, and grey sandy clay (Danielssen and Koren).

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Korethraster hispidus. .	Atlantic.	101 to 632	Mud; Clay (coarse and sandy).

1. *Korethraster hispidus*, Wyville Thomson (Pl. LXXX. figs. 6–9).

Korethraster hispidus, Wyville Thomson, 1873, The Depths of the Sea, pp. 119, 120, fig. 15.

Locality.—"Porcupine" Expedition:

Station 57, 1869. In the Faeröe Channel. Lat. 60° 14′ N., long. 6° 17′ W. Depth 632 fathoms. Bottom temperature −0°·8 C.; surface temperature 11°·1 C.

Remarks.—This species has been so fully and ably described by Danielssen and Koren,[1] and previously by von Marenzeller,[2] that I consider it superfluous to re-describe the species. Through the kindness of Dr von Marenzeller I have examined the example collected during the "Tegetthoff" Expedition by Mr Julius Payer, and I can confirm the accuracy of his determination. I have therefore limited myself to giving an illustration of the original example dredged by the "Porcupine"; and I have included in the foregoing generic diagnosis reference to several points of structure which appear to have escaped the notice of previous observers.

Genus *Peribolaster*, Sladen.

Peribolaster, Sladen in Narr. Chall. Exp., 1885, vol. i. p. 616.

Form stellate. Rays rather short and broad. Disk large, more or less inflated. Abactinal surface convex. Actinal surface plane. Margin angular. Interbrachial arcs acute.

Abactinal surface with cruciform plates having delicate prolongations or supplementary trabeculæ, which impinge on the adjacent plates, and form a regular network with large quadrangular meshes over the entire surface. On the centre of each abactinal plate is borne on a small boss a fascicule of delicate, equal spinelets, the spinelets being enveloped in membranous sheaths which are united in the interior of the fascicule. The fascicules are isolated and well spaced. Several papulæ are present in each interspace or mesh.

[1] Den Norske Nordhavs-Expedition 1876–1878, Zoologi, xi. Asteroidea, 1884, p. 95, tab. xii.

[2] *Denkschr. d. k. Akad. d. Wiss. Wien, math.-naturw. Cl.*, 1877, Bd. xxxv., p. 283.

Adambulacral plates with an armature forming with that of the infero-marginal plates (and actinal intermediate plates if present) a transverse series of large, single, isolated spinelets, invested with membranous sacs. (Six are present in transverse series in the type form.)

Mouth-plates with a prominent median keel. Armature consisting of: (1.) A marginal series of six mouth-spines on each plate, the innermost one much larger than the others; all invested with membrane. (2.) On the actinal surface of the plate is one large secondary mouth-spine in a membranous sheath, placed immediately behind the large innermost marginal mouth-spine.

Madreporiform body very large and irregularly oval in outline, the margin being festooned. Surface grooved with numerous fine striations.

Ambulacral furrows wide. Tube-feet large and crowded, forming four rows; with a fleshy, button-like, terminal disk.

No pedicellariæ of any kind present.

Remarks.—This handsome and well-characterised form is undoubtedly allied in many points of structure to *Korethraster*. *Peribolaster* is, however, at once distinguished by the reticulate abactinal skeleton, by the cruciform plates composing it, by the sheathed fascicules of the abactinal plates, by the presence of papulæ on the abactinal surface, by the extraordinarily large madreporiform body, and by the quadruple series of ambulacral tube-feet.

Chorology of the Genus Peribolaster.

α. Geographical distribution:—

Pacific: One species between the parallels of 45° and 50° S.

Peribolaster folliculatus, off the west coast of Patagonia.

β. Bathymetrical range: 45 fathoms.

γ. Nature of the Sea-bottom: Green sand.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Peribolaster folliculatus . .	Pacific.	45	Green sand.

1. *Peribolaster folliculatus*, n. sp. (Pl. LXXIII. figs. 4–7).

Rays five. R = 54 mm.; r = 18 mm. R = 3 r. Breadth of a ray at the base, about 20 mm.; and midway between this and the extremity about 17·5 mm., measured outside the spinelets.

Form stellate. Rays rather short and broad, the length from the interbrachial arc being about equal to the diameter of the disk. The interbrachial arcs are acute, and the rays are broad at their base and taper only slightly as they proceed outward until close to the extremity, where they taper abruptly and rapidly to a pointed tip, which is turned upward. This recurvature of the tip causes the rays to have a more or less obtuse appearance when casually viewed from above, and the character is further emphasised by the slight degree of tapering along the greater portion of their length. The breadth of the ray is greater than the height; and the abactinal surface is convex, uniting with an angular margin to a plane actinal surface. A transverse section of the ray would thus present a regular plano-convex outline.

The disk is well developed, subdepressed, convex, and slightly inflated, its height not much greater than that of the rays at the base. The abactinal skeleton of the disk and rays alike consists of cruciform ossicles, in the shape of a St. Andrew's cross, with delicate prolongations, or supplementary trabeculæ, the extremities of which impinge on the corresponding extremities of adjacent ossicles; the whole forming a very regular network over the entire surface. On the centre of each of these ossicles is borne, on a little boss, a fascicule of three to six moderately elongate delicate spinelets, of equal length, which radiate apart very slightly. The spinelets are each enveloped in a rather thick membranous sheath, and the sheaths of the respective spinelets are united in the interior part of the fascicule, so that, although the sheathed spinelets have the superficial appearance of maintaining their independence, they are in reality bound together, and the spinelets constituting a fascicule are in consequence probably capable of but very limited expansive movement. The fascicules of spinelets are isolated and tolerably spaced; and the length of the spinelets diminishes as they proceed along the ray; the spinelets, however, increase in length as they approach the margin of the ray, and those of the series at the extreme margin are stout and robust, with usually four spinelets in each fascicule. In the interspaces or meshes of the calcareous network are a number of small, vermiform, almost thread-like papulæ, from three to six in each.

The armature of the adambulacral plates forms a continuous series with that of the plating which extends up to the margin of the ray. Six isolated spines form a single transverse row between the furrow and the marginal series of fascicules; and each is articulated upon a small rounded boss or tubercle. The innermost spine is very small and situated quite within the furrow; the next is much larger, whilst the third and succeeding spinelets are longer, and are the largest on the test. Each of these spinelets is enclosed in a membranous sheath, which, in the case of the two nearest the furrow, has elongate saccular prolongations, that of the small inner spinelet being thin and threadlike. The sheaths of the outer spines are stouter and more fleshy in appearance, and are little if at all prolonged. The intermediate space between the spinelets is so thickly covered with membrane that even after removing a few of the spines, I am unable to say whether

two or three should be counted as belonging to the adambulacral plates. The question can only be decided by dissection and preparation, a step which would entail greater mutilation than I consider desirable in the case of a unique specimen. The plate upon which the outer spinelets are borne is slightly curved upward to the margin.

The mouth-plates are prominent, with an elevated angular keel along their line of juncture, terminating aborally in a rounded but prominent peak. The adoral margin projects into the actinostome, but its prominence is masked by the position of the three mouth-spines proper which stand on each side. The innermost is the longest, and situated close to the adoral peak; the other two are smaller, the outer one being the least. At the outer angle of the plate adjacent to the adambulacral plate are three small spinelets placed in a semicircle, which should probably also be ranked as mouth-spines. A single large secondary mouth-spine is placed on the surface of the plate immediately behind the innermost of the marginal mouth-spines, and is both longer and stouter than these. All the mouth-spines are enveloped in membranous sheaths, those of the two inner mouth-spines and the secondary being thick and fleshy, the others more delicate and with saccular prolongations.

The madreporiform body is very large and irregularly suboval in outline, the margin being festooned by prolongations, having the appearance of flowing out between the widely spaced fascicules by which the plate is surrounded. The central portion is slightly elevated, subconical rather than convex, and somewhat undulating in conformity with the marginal projections. The surface is covered with numerous very fine striations, which radiate from the centre. The major axis of the body measures 9 mm., and the minor 7·5 mm. Its position on the disk is somewhat nearer the centre than midway between that point and the margin.

A large aperture, 2 to 2·5 mm. in diameter, exists at a considerable distance from the centre; a muscular ring is traceable, and some cæcum-like structures are slightly protruded. This is probably the anal aperture, but its very excentric position is remarkable, being nearly midway between the centre and the margin, and when the madreporite is placed in the right anterior interradium, a line drawn through the centre of that plate, parallel to the antero-posterior axis of the starfish, would bisect the orifice.

No pedicellariæ are present.

The ambulacral furrows are very wide, and the tube-feet form by crowding four rows; each tube-foot is furnished with a fleshy, button-like, terminal disk somewhat larger in diameter than the adjacent portion of the tube, and the centre shows an invaginated depression.

The actinostome is large, measuring about 13·5 mm. in diameter, and the mouth-plates could not be apposed.

The actinal interradial areas are very limited, and any additional intermediate plates that may be present beyond the representatives of those entering into the composition of the ray are very few in number.

Colour in alcohol, a bleached yellowish white. The large madreporiform body is conspicuous by its slightly orange shade of light brown.

Locality.—Station 304. Off the Peninsula of Tres Montes, west coast of Patagonia. December 31, 1875. Lat. 46° 53′ 15″ S., long. 75° 12′ 0″ W. Depth 45 fathoms. Green sand. Surface temperature 57°·2 Fahr.

Family Pterasteridæ, Perrier, 1875.

Prior to the Challenger Expedition this family was represented by a very limited number of forms, only nine species being on record. Eight of these belonged to the genera *Pteraster* and *Retaster*, and the ninth was the type and solitary representative of *Hymenaster*, a genus established by Sir Wyville Thomson for a remarkable Asterid discovered during the cruise of H.M.S. "Porcupine."

Thirty-five species of Pterasteridæ were obtained by the Challenger, only two of which were previously known. Of the thirty-three new species, three belong to *Pteraster*, four to *Retaster*, and the remarkable number of twenty to *Hymenaster*, a genus which is now found to possess a world-wide distribution in deep waters. The remaining six species are representatives of four new genera, viz. :—*Marsipaster*, two species; *Benthaster*, two; *Calyptraster*, one; and *Pythonaster*, one.

Two new genera have been recently added to the family by Perrier, viz., *Myxaster*[1] and *Cryptaster*;[2] but the brief notices which are given of these interesting forms are too short to enable me to class them satisfactorily in the subjoined synopsis.

Note on Terminology.—For the sake of brevity, and to avoid verbose repetition, several terms are employed in the following descriptions which have not previously been used in their present special signification. The introduction of these terms is necessitated by structural peculiarities in the forms comprised in the family Pterasteridæ, several of which have hitherto been unobserved, whilst others have been ignored or passed over by previous systematists. The application of the terms will, in most cases, be self-evident. The following is a brief definition.

The *supradorsal membrane* is the veil-like covering or external independent tissue whereby the dorsal nidamental cavity is formed. The membrane is supported above the true abactinal surface of the animal by the paxillæ, which consist of a long columnar pedicle surmounted by a "crown" of fine, more or less elongate spinelets. In the majority of forms belonging to this family, fine muscular fibrous bands extend between the tips of the spinelets and constitute a more or less regular fibrous network; and the general tissue of the supradorsal membrane which fills in the interspaces or meshes is usually perforated by small contractile pores, styled *spiracula* by Sars. A large aperture occurs in the

[1] *Comptes rendus*, 1885 (November), t. ci. p. 886.

[2] *Ann. Sci. Nat.* (Zool.), 1885, 6e Série, t. xix., art. No. 8, p. 69.

supradorsal membrane, situated over the centre of the disc and opening directly into the dorsal cavity, to which it affords a common means of ingress and egress; it is named the *oscular orifice*. This aperture may be closed by five more or less regular fan-like valves, or simply by a number of webbed or papillose spinelets. A number of small apertures open into the nidamental cavity on the actinal surface of the starfish, an aperture being situated at the base of each of the long actino-lateral spines and close up to the adambulacral plate. There is consequently an opening into the cavity on each side of the furrow corresponding to each segment of the ray; hence these are spoken of as *segmental apertures*. The openings are guarded and can be closed by a small spinelet or papilla articulated on the adambulacral plate, and termed the *aperture-papilla*. In some genera these appendages are partially hidden in the actinal membrane, and are free on one side only; in others they are perfectly free, and covered with a more or less expansive investing membrane of their own. The long spines articulated on the body-frame close to the adambulacral plates, which form the lateral or marginal web in *Pteraster*, and support the whole actinal floor in *Hymenaster*, are designated the *actino-lateral spines*. Finally, in the armature of the mouth-plates distinction is made between (1) *mouth-spines proper*, which are situated upon the horizontal margins of the plates, and are usually directed over the actinostome; and (2) the *secondary* or *superficial mouth-spines*, which are borne upon the surface of the plate, and usually stand perpendicular to its plane—these latter spinelets being also frequently larger and more robust than the mouth-spines proper.

Synopsis of the Genera included in the Family PTERASTERIDÆ.

A. A supradorsal membrane present. With actino-lateral spines. With segmental apertures. Form disco-pentagonal, rays slightly produced. Abactinal spinelets long, forming highly developed pedicellated paxillæ . . . . . PTERASTERINÆ.

a. Armature of the adambulacral plates forming transverse combs. Spines united by web.

a. Supradorsal membrane with muscular fibrous bands. Actino-lateral spines forming a free independent lateral fringe; not merged in the actinal floor.

α. Muscular bands not reticulated. Membrane usually containing spicules . . . . . *Pteraster*.

β. Muscular bands regularly reticulated. No spicules in the membrane . . . . . *Retaster*.

b. No muscular fibrous bands in the supradorsal membrane. Actino-lateral spines merged in the actinal floor. No lateral fringe.

α. Paxillæ-spinelets (fifteen to thirty), long and hair-like, protruding freely through the membrane. Adambulacral armature partly horizontal in disposition. One pair of secondary mouth-spines; united by web to the mouth-spine series . . *Marsipaster*.

β. Paxillæ-spinelets (five or six), short, robust, not protruding. Adambulacral armature perpendicular in disposition.

Three pairs of secondary mouth-spines, free and independent	*Calyptraster.*
b. Armature of the adambulacral plates not forming transverse combs. Spines independent and not united by web.	
a. Nidamental cavity spacious. Supradorsal membrane well-developed. Muscular fibres present. Spiracula present. Spinelets of paxillæ short, not protruding through, but supporting, the membrane	*Hymenaster.*
b. Nidamental cavity aborted. Supradorsal membrane rudimentary. No muscular fibres. No spiracula. Spinelets of paxillæ fascicular, protruding a great portion of their length naked through the membrane	*Benthaster.*
B. No supradorsal membrane present. No actino-lateral spines. No segmental apertures. Form stellate, rays greatly produced, attenuate and cylindrical. Abactinal spines short, in sheathed fascicules, not forming pedicellate paxillæ	PYTHONASTERINÆ.
a. A single genus	*Pythonaster.*

Subfamily PTERASTERINÆ, Sladen, 1888.

Genus *Pteraster*, Müller and Troschel.

Pteraster, Müller and Troschel, System der Asteriden, 1842, p. 128.

With the exception of two Atlantic species, *Pteraster caribbæus* and *Pteraster sordidus*, all the members of this genus are confined to the colder temperate and frigid zones. Notwithstanding its wide range of distribution the genus appears to show only a comparatively small amount of morphological plasticity.

Chorology of the Genus Pteraster.

a. *Geographical distribution* :—

ATLANTIC : Five species between the parallels of 80° N. and 60° S.

**Pteraster militaris*, off the Norwegian, British, and North American coasts, extending up Smith's Sound as far as Dobbin Bay, and south to Cape Cod, off Spitzbergen and Nova Zembla, and in the Kara Sea. *Pteraster pulvillus*, off the Norwegian and North American coasts, as far south as Chesapeake Bay (2021 fathoms, *fide* Verrill), off Nova Zembla and the Murman coast. *Pteraster caribbæus*, from the West Indian area. *Pteraster danæ*, off the east coast of Patagonia (or (?) Rio Janeiro). *Pteraster sordidus* is an Atlantic species mentioned by Perrier by name only, but of which no description is published.

Southern Ocean: Three species between the parallels of 40° and 60° S.

**Pteraster affinis*, off Kerguelen. **Pteraster rugatus*, from between Kerguelen and Heard Islands. **Pteraster semireticulatus*, off Marion Island.

Pacific: Two species between the parallels of 70° (?) N. and 60° S.

**Pteraster stellifer*, off the western coast of South America. *Pteraster aporus*, from Bering Sea.

β. *Bathymetrical range:* 10 to 2021 fathoms.

Greatest range of one species: *Pteraster pulvillus*, 50 to 2021 fathoms.

Excepting *Pteraster militaris* and *Pteraster sordidus*, none of the other species extend into the Abyssal zone. *Pteraster caribbæus* and *Pteraster stellifer* occur in the Continental zone.

γ. *Nature of the Sea-bottom:* Mud, sandy clay, or gravel.

Pteraster affinis and *Pteraster caribbæus* on mud. *Pteraster militaris* on sandy clay or shelly ground. *Pteraster rugatus* on coarse gravel. *Pteraster stellifer* on Blue mud.

The species collected by the Challenger are indicated in the foregoing list by an asterisk.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Pteraster affinis	Southern.	28	Volcanic mud.
Pteraster aporus	Pacific.	...	...
Pteraster caribbæus	Atlantic.	151 to 451	Soft grey mud.
Pteraster danæ	Atlantic.	30 (?)	...
Pteraster militaris	Atlantic.	10 to 530	Gravel, stones, sandy clay, or shelly ground.
Pteraster militaris, var. *prolata*	Atlantic.	608	...
Pteraster pulvillus	Atlantic.	50 to 2021	...
Pteraster rugatus	Southern.	150	Coarse gravel.
Pteraster semireticulatus	Southern.	50	...
Pteraster sordidus	Atlantic.	622	...
Pteraster stellifer	Pacific.	245	Blue mud.

1. *Pteraster militaris*, Müller and Troschel.

Asterias militaris, O. F. Müller, 1776, Zool. Dan. Prodr., p. 234, No. 2828.
Asteriscus militaris, Müller and Troschel, 1842, System der Asteriden, p. 44.
Pteraster militaris, Müller and Troschel, 1842, System der Asteriden, p. 128, tab. vi. fig. 1.

Locality.—Station 49. South of Halifax, Nova Scotia. May 20, 1873. Lat. 43° 3′ 0″ N., long. 63° 39′ 0″ W. Depth 85 fathoms. Gravel, stones. Bottom temperature 35°·0 Fahr.; surface temperature 40°·5 Fahr.

"Triton" Expedition:

Station 2. In the Faeröe Channel. August 5, 1882. Lat. 59° 37′ 30″ N., long. 6° 49′ 0″ W. Depth 530 fathoms. Bottom temperature 46°·2 Fahr.

1*a*. *Pteraster militaris*, var. *prolata*, Sladen.

Pteraster militaris, var. *prolata*, Sladen, Trans. Roy. Soc. Edin., vol. xxxii. p. 153, pl. xxvi. fig. 1.

This variety is characterised by the following points:—The great length and narrowness of the rays. $R > 3\,r$; $R = 58$ to 60 mm.; $r = 18$ mm.; breadth of a ray at the base, 18 to 22 mm. extreme measure. The abactinal paxillæ appear usually to have one of their spinelets much more robust than the two or three companion spinelets, which are remarkably fine and delicate, and the tips of the spinelets can scarcely be said to protrude through the supradorsal membrane, notwithstanding that this latter is placed loosely upon them and much wrinkled. Two or three lineal series of paxillæ are more or less clearly distinguishable along the sides of the rays. On the actinal surface the segmental apertures are remarkably large, and the aperture-papillæ are much broader and more robust at their proximal portion than in *Pteraster militaris*. In the armature of the adambulacral plates the inner three spines of each transverse comb form a line oblique to the furrow, the comb being curved aborally at the margin of the furrow, and the position of these spines upon the adambulacral plate being also oblique in relation to the plane of the ray. The actino-lateral spines are very short, and the outer portion of the web which proceeds from the outermost spine of the adambulacral armature, *i.e.*, the membranous continuation of the transverse comb upon the actinal membrane, is much more prominent than in the typical form of the species, and extends up to the margin of the lateral fringe. Although these differences may appear insignificant verbally, they produce when combined a striking facies, the characters of which can hardly be explained, as being simply the modifications of the normal form consequent on the conditions of a deep-water habitat, since an example of *Pteraster militaris* from 530 fathoms from a neighbouring station, differs in no way from the normal form.

Locality.—"Triton" Expedition:

Station 9. In the Faeröe Channel. August 23, 1882. Lat. 60° 5′ 0″ N., long. 6° 21′ 0″ W. Depth 608 fathoms. Bottom temperature 30°·0 Fahr.

Remarks.—This is a remarkable form, differing greatly in general appearance from the normal type of *Pteraster militaris;* and although it accords in the main with the diagnostic formula of that species, the majority of the characters differ more or less in degree. It is not improbable that a series of examples might ultimately warrant its being ranked as a distinct species; but for the present I prefer to place the solitary specimen known to me as a variety of *Pteraster militaris*, until further material is available, a course which is sufficient to identify the form and at the same time indicate the nearest specific affinities.

2. *Pteraster affinis*, Smith.

Pteraster affinis, E. A. Smith, 1876, Ann. and Mag. Nat. Hist., ser. 4, vol. xvii. p. 108; Phil. Trans., Zool. Kerguelen Island, 1879, vol. clxviii. p. 275, pl. xvi. fig. 5.

Locality.—Station 149D. Royal Sound, Kerguelen Island. January 20, 1874. Lat. 49° 28′ 0″ S., long. 70° 13′ 0″ W. Depth 28 fathoms. Volcanic mud. Surface temperature 41°·0 Fahr.

3. *Pteraster rugatus*, Sladen (Pl. LXXIV. figs. 3 and 4; Pl. LXXVII. figs. 3 and 4).

Pteraster rugatus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 192.

Marginal contour subpentagonal, interbrachial arcs scarcely indented, the minor radius being in the proportion of 68·4 per cent. R = 9·5 mm.; $r = 6·5$ mm. Interradial margin rounded, extremities of the rays slightly upturned, exposing the end of the furrow. Abactinal profile rounded, not high, tapering but little towards the extremities of the rays. Actinal surface flat or slightly convex. Lateral fringe very slightly produced beyond the margin of the test.

The supradorsal membrane is subcorrugated and is not reticulated. The paxillæ-spinelets are fine, about five or six in number, and their tips are slightly protuberant, producing a slight papillate appearance on the abactinal surface; no regularity of arrangement is perceptible. The membrane is indurated with minute spicules averaging 0·03–0·04 mm. in length, which are small, irregular, and angularly-branching bodies, subdendriform in appearance and fairly well spaced. The spiracula are rather large, not numerous, and are irregularly placed.

The ambulacral furrows are narrow, uniform in breadth till near the extremity, and not petaloid. The ambulacral tube-feet are disposed in regular simple pairs. The armature of the adambulacral plates consists of short and rather robust spinelets, three or four in each comb, but three only on the outer part of the ray. The innermost spine is nearly as long as the others, or, if a small inner one be present, it may be more or less aborted and invisible without dissection. The web is remarkably thick and fleshy, subsaccular over the spinelets, and passes off from the outermost spine with a long gentle sweep far out upon the lateral fringe.

The mouth-plates each bear on their margin about three rather short, robust mouth-spines webbed together. There is one secondary or superficial mouth-spine on the actinal surface of each plate, perpendicular to the plane, longer than any of the other spines, exceedingly thick, triangular, translucent, sharply pointed, and covered with a thick fleshy investment.

The aperture-papillæ are large, prominent, and subtriangular. The actino-lateral spines, which are directed horizontally, are comparatively long, specially in the interradial area. The web is rather thick and fibrous.

Colour in alcohol, greyish white.

Locality.—Station 150. Between Kerguelen Island and Heard Island. February 2, 1874. Lat. 52° 4′ 0″ S., long. 71° 22′ 0″ E. Depth 150 fathoms. Coarse gravel. Bottom temperature 35°·2 Fahr.; surface temperature 37°·5 Fahr.

Remarks.—*Pteraster rugatus* may be readily recognised by its almost pentagonal form and by the rugose character of the abactinal (supradorsal) area. It also differs from the other members of the genus in structural details, which need not be recapitulated.

4. *Pteraster stellifer*, Sladen (Pl. LXXIV. figs. 1 and 2; Pl. LXXVII. figs. 1 and 2).

Pteraster stellifer, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 193.

Marginal contour stellato-pentagonoid, interbrachial arcs slightly indented, the minor radial proportion being 67·6 per cent. R = 34 mm.; r = 23 mm.

Rays very broad at the base, and tapering to a fine extremity, which is slightly recurved, margins of the rays not curved outward. Abactinal surface depressed and flatly convex. Lateral fringe scarcely extending beyond the margin. Actinal surface flat.

The supradorsal membrane, which is rather thick, regularly papillose in appearance, and not reticulated, is composed of closely interlacing fibrous tissue. The paxillæ are numerous and closely placed, having crowns of usually six spinelets radiating round a central one; the expansion of the spinelets is slight, and all are uniformly protuberant. The tips of the spinelets elevate the membrane into little conical papillæ, which, in consequence of the regularity of the crowns of the paxillæ, have the appearance of forming six-rayed stars with a central papilla, raised slightly in relief above the general superficies. The crowns are closely placed, with the interspaces rather deep; and the "stars" often appear to overlap. A more or less distinct lineal arrangement of this ornamentation may be observed upon the rays, although here and there irregular paxilla-crowns, with fewer or more minute spinelets, as the case may be, are interspersed. The "stars" diminish in size as they proceed outward on the ray. The spiracula are small and rather widely spaced. The oscular orifice is small, and the spinelets of the valves are short and crowded.

The ambulacral furrows are narrow, straight, not petaloid, and converge gradually towards the extremity. The tube-feet are arranged in simple pairs. The borders formed by the transverse combs of spinelets on the adambulacral plates are rather broad. The armature of the adambulacral plates consists of a comb of five comparatively short spinelets, the innermost one diminutive, not half the length of the others, and placed aborally to them on the plate, the comb being thus curved round aborally at the margin of the furrow; the spine next to the outermost is usually the longest. The web, which is moderately thick and semitransparent, is rather deeply incurved between the spinelets, somewhat thickened round them, and slightly sacculate over their extremities; it is continued from the outermost spine of the comb far out upon the actino-lateral spines.

The segmental apertures are rather large and conspicuous for this genus. The aperture-

papilla is comparatively large, and free on its aboral side only, forming a regular semicircular lip, the remainder of the papilla being entirely hidden in membrane.

The mouth-plates are short, but widely expanded laterally, rising by a gradual slope into a high and angular median keel, which forms a prominent peak aborally. Each plate bears one moderately robust secondary or superficial spine placed rather nearer the anterior margin of the plate than the middle. These spines are shorter than the mouth-spines proper, and are covered with a thick investing-membrane slightly sacculate at the extremity. Five mouth-spines are situated on the horizontal margin of each plate, the innermost the longest, the next slightly smaller, and the outer three much smaller. Each of the spines is covered with a moderately thick subsacculate investing membrane; and no web is developed, except in a single abnormal instance, where a secondary spine is united with the inner or first mouth-spine proper.

The first or most adoral transverse combs of the adambulacral plates of two neighbouring rays touch one another at their bases behind the aboral peak of the mouth-plates, but are not joined together.

The actino-lateral spines are long, delicate, closely placed, and extend to the margin of the actinal surface; the web is faintly rounded over their extremities and slightly festooned between. The spines are horizontal in their disposition, forming a flat actinal surface to the disk; the fringe extends very slightly beyond the margin; and the spines diminish to quite microscopic proportions at the extremities of the ray.

Colour in alcohol, a general pinkish white on the abactinal area, verging on flesh colour. The actino-lateral spines, the spines of the adambulacral armature, the mouth-plates, and the mouth-spines, are all of a delicate rosy pink colour; and this, seen through the semitransparent light flesh-coloured investing tissue, gives an exquisitely beautiful appearance to the underside of the starfish.

Locality.—Station 311. Off the entrance to Smyth Channel. January 11, 1876. Lat. 52° 45′ 30″ S., long. 73° 46′ 0″ W. Depth 245 fathoms. Blue mud. Bottom temperature 46°·0 Fahr.; surface temperature 50°·0 Fahr.

Remarks.—This remarkably handsome species is distinguished from all other forms by the regular stellate character of the paxillæ-crowns, by the armature of the adambulacral plates, and by the general character of the actinal surface.

5. *Pteraster semireticulatus*, Sladen (Pl. LXXV. figs. 5 and 6; Pl. LXXVII. figs. 5 and 6).

Pteraster semireticulatus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 195.

Marginal contour substellate; interbrachial arcs well indented, the minor radial proportion being 57 per cent. R = 14 mm.; $r = 8$ mm. The sides of the rays slightly and gracefully curve outward, and the tips are naturally upturned and incised, bringing the extremity of the ambulacral furrow upon the abactinal area. Abactinal profile rather high

and bombous over the disk, tapering off rather steeply to the extremity of the rays. Actinal surface slightly concave.

The supradorsal membrane is marked out with conspicuous reticulated lines of membrane, although no regular divisional fibres or independent tendinous network can be made out—the fibres present being fine and only distinguishable when highly magnified. The paxillæ are moderately long, with the spinelets radiating well outward, about six to eight or even more in number; the corrugated membrane which they support lying thick and baggy over their tips, and forming the regular lines and cross-lines whereby the character above noted is produced. None of the spinelets are more prominent than the rest; and, although a central one appears to be normally present in the centre of the mesh, this is very frequently absent towards the end of the rays. The membrane is semitransparent, and contains no spicules; six to ten large-sized, irregularly disposed spiracula occur in each mesh-like area.

The ambulacral furrows are moderately wide and sublanceolate; the tube-feet more or less alternate, and show distinctly a tendency towards quadruple arrangement. The armature of the adambulacral plates consists of moderately long and slender spinelets, each comb having three or four (and occasionally five); the innermost spinelet is not more than one-third of the size of the next, and is placed in advance of, or aboral to, the rest of the comb; the outer spinelet is usually rather longer than the others. The web-membrane is semitransparent, moderately indented, and after passing from the outermost spinelet of the comb, is attached to the web of the actino-lateral spine slightly in advance of the actino-lateral spine belonging to its own adambulacral plate—the spinelet hanging right over the terminal piece of web, which does not reach far out as in *Pteraster rugatus*. A rather long saccular prolongation of the web-membrane occurs at the tip of each of the spines of the adambulacral comb. Towards the extremities of the rays the combs sometimes show a tendency to separate into component spines, each being still clothed with membrane. The aperture-papillæ are somewhat jawbone-shaped, the thickened extremity being directed adorally.

The mouth-plates bear four or five spines on each side, which are long and stouter than the spines of the adambulacral armature, both series being webbed together; the outer spine is sometimes very small and rudimentary. The secondary or superficial spines are small, not so long as the innermost mouth-spines, but rather more robust. In one or two plates of the specimen under notice there is a single irregular secondary spinelet, smaller than and accompanying those just referred to. The first adambulacral comb after the mouth-plate series has its web continued upon the aboral extremity of the mouth-plate; hence these two combs meet.

The actino-lateral spines are of moderate length and slender; the fringe, which extends a short distance free beyond the margin of the test, is directed horizontally or in the plane of the actinal surface.

Colour in alcohol, greyish white.

Locality.—Station 144A. Off Marion Island. December 26, 1873. Lat. 46° 48′ 0″ S., long. 37° 49′ 30″ E. Depth 69 fathoms. Volcanic sand. Surface temperature 41°·0 Fahr.

Remarks.—This species is remarkable for the manner in which it simulates the structure of *Retaster* in the character of the supradorsal membrane and also, though to a less degree, in the character of the web and of the investment of the spines constituting the adambulacral armature. These points distinguish *Pteraster semireticulatus* from all other species of *Pteraster* with which I am acquainted.

Genus *Retaster*, Perrier.

Retaster, Perrier, Nouv. Archives Mus. Hist. Nat., 1878, 2e Série, t. i. p. 56.
Diplopteraster, Verrill, Amer. Journ. Sci. 1880, vol. xx. p. 400.

Although the differences which separate *Retaster* from *Pteraster* are comparatively slight superficially, their constancy and their morphological significance appear to me to justify generic recognition. If I am right in referring *Pteraster multipes* to this genus (as I think I am) the name *Diplopteraster*, proposed by Verrill, will fall as a synonym of later application.

Chorology of the Genus Retaster.

a. Geographical distribution:—

Atlantic: Three species between the parallels of 70° N. and 60° S.

Retaster multipes, off the coasts of Norway and North America, extending as far south as Cape Hatteras. *Retaster capensis*, from the Cape of Good Hope. **Retaster verrucosus*, near the entrance to the Strait of Magellan.

Indian Ocean: One species between the parallels of 0° and 30° S.

Retaster cribrosus from Zanzibar and Mozambique; and extending to the Philippine Islands.

Southern Ocean: One species between the parallels of 45° and 55° S.

**Retaster peregrinator*, from Kerguelen Island.

Eastern Archipelago: Two species between the parallels of 20° N. and 20° S.

Retaster cribrosus, from the Philippine Islands and extending into the Indian Ocean to the east coast of Africa. **Retaster insignis* from Torres Strait and the Banda Sea, and extending to Port Molle (*fide* Bell).

Pacific: Two species between the parallels of 20° and 60° S.

**Retaster gibber*, off the western coast of Patagonia. **Retaster insignis*, off Port Molle (*fide* Bell), and extending into the Eastern Archipelago.

β. *Bathymetrical range:* 6 to 640 fathoms.

Greatest range of one species: *Retaster multipes*, 124 to 640 fathoms.

All the other species whose depth is known are confined to the Littoral zone, with the exception of *Retaster gibber*, which extends into the Continental zone.

γ. *Nature of the Sea-bottom: Retaster multipes* occurs on greenish clay; *Retaster verrucosus* on Sand; *Retaster peregrinator* on Volcanic mud; *Retaster gibber* on Blue mud; *Retaster insignis* on Coral mud and Green mud.

The species collected by the Challenger are indicated in the above list by an asterisk.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Retaster capensis	Atlantic.	...	...
Retaster cribrosus	Indian and Eastern Archipelago.	...	...
Retaster gibber	Pacific.	245	Blue mud.
Retaster insignis	Eastern Archipelago and Pacific.	6 to 25	Coral mud; Green mud.
Retaster multipes	Atlantic.	124 to 640	Greenish clay.
Retaster peregrinator	Southern.	127	Volcanic mud.
Retaster verrucosus	Atlantic.	55	Sand.

1. *Retaster verrucosus*, Sladen (Pl. LXXVI. figs. 1 and 2; Pl. LXXVII. figs. 9 and 10).

Retaster verrucosus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 196.

Marginal contour moderately indented in the interradia, which are angular and not rounded; outline of the rays gracefully curved outwards. The minor radius is in the proportion of 59·5 per cent. R = 47 mm.; $r = 28$ mm. Abactinal profile moderately high and rounded, tapering gradually to the extremity of the rays, which are slightly upturned and expose the ambulacral furrow on the abactinal area. Actinal surface flat.

The supradorsal membrane is very regularly and uniformly reticulated. The paxillæ have long pedicles, and bear a crown of about fifteen spinelets, nearly as long as the pedicle. The central spinelet, which is very much more robust and longer than any of the rest, stands perpendicular, rising in the centre of the mesh, whilst the others, which are slender and delicate, radiate round it and outward to the fibrous bands that form the outline of the mesh. The median spinelet is much more prominent than any of the others; and the thick fleshy cap formed upon it by the supradorsal membrane imparts a very conspicuous papillate appearance to the starfish, assuming in large specimens almost a semi-tuberculate character of great regularity and evenness of disposition. In fully grown specimens the whole membrane becomes very thick and wrinkled, rendering it difficult to trace the radiating bands; in moderate-sized specimens, however, they may be clearly distinguished without removing the epidermis. From the central spinelet six to eight

secondary muscular fibres radiate up to the main fibres of the mesh ; they are of considerable thickness, and leave only narrow interspaces, in which four or five small spiracula occur.

The ambulacral furrows are very broad and petaloid in outline ; and the tube-feet are arranged in quadruple series. The transverse combs of spines on the adambulacral plates are numerous and closely placed. The armature of the adambulacral plates consists of five moderately long and robust spines, the uniting web being thick, fleshy, and with long saccular prolongations extending beyond the tips of the spines. The adambulacral spinelets are nearly equal in length, except the innermost, which is shorter and more delicate. Each alternate row or comb is somewhat retired from the furrow margin ; and in these combs the innermost spinelet is very much smaller than its companions, in some cases almost aborted. This spine is usually placed rather in advance of its row.

The mouth-plates are armed with long mouth-spines, four on each plate, all the eight webbed together, not radiating apart, but forming a narrow scoop-like fan, the inner three spines on each plate being about equal in length, but the outermost spine is very small and short. The secondary or superficial mouth-spines (one on each plate) are not longer than the mouth-spines, scarcely if at all stouter, subcylindrical, not pointed, and covered rather thickly with membrane.

The actino-lateral spines are completely hidden in a very thick fleshy membrane, which extends as a saccular prolongation beyond their extremities, forming an aborted lateral fringe projecting slightly beyond the margin of the disk and rays.

Colour in alcohol, varying from light warm brown to purplish grey.

Locality.—Station 313. Near the Atlantic entrance to the Strait of Magellan. January 20, 1876. Lat. 52° 20′ 0″ S., long. 67° 39′ 0″ W. Depth 55 fathoms. Sand. Bottom temperature 47°·8 Fahr. ; surface temperature 48°·2 Fahr.

Remarks.—Although this species bears much resemblance in outline and general form to *Retaster peregrinator*, it may be at once distinguished by the character of the abactinal surface, the structure of the paxillæ, and the armature of the adambulacral plates. A six-rayed example of this species, of great regularity and beauty, was also obtained.

2. *Retaster peregrinator*, Sladen (Pl. LXXV. figs. 1–4).

Retaster peregrinator, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 198.

Marginal contour not greatly indented, the minor radius being in the proportion of 65·85 per cent. R = 41 mm. ; r = 27 mm. Interbrachial arcs subangular or faintly rounded. Rays short, thick, blunt, and rounded at the extremities, which are slightly upturned. Abactinal profile bombous and rather high. Actinal area flat or subconvex.

The supradorsal membrane is thick and regularly reticulated. The paxillæ have a crown of five to ten spinelets, one directed to the centre of the mesh, the rest expanded very slightly ; six radiating fibrous bands pass from the central spinelet to the mesh

fibres; and the interspaces include two or three large spiracula. All the spinelets are uniformly protuberant, and that only to a slight degree; they are rather closely placed, and the whole abactinal area is thickly covered with rather fleshy wrinkled skin, presenting a somewhat spongy and subpapillose appearance, and a slightly scabrous feeling to the touch. The primary meshes are not very distinctly marked out superficially, and the hexagons consequently appear to overlap or run into one another in many cases. The oscular orifice is small and inconspicuous.

The ambulacral furrows are broad and more or less petaloid, the closely placed and prominent transverse adambulacral spine-combs adding greatly to the appearance of breadth. The tube-feet are arranged in quadruple series. The combs of spines forming the adambulacral armature are broad, a feature further enhanced by their method of arrangement. Each alternate comb has usually two spines less; in this way combs of seven to eight spinelets alternate regularly with combs of five. The larger combs radiate well over the furrows, whilst the smaller ones, on the other hand, are considerably retired from the margin, the innermost spine standing perpendicularly, or even directed slightly outward. Hence when seen from above, the smaller combs appear to occupy little more than one-half, or at most two-thirds, the space of the larger combs. In the larger combs the innermost spine is smaller and shorter than the rest, frequently not more than half the length. In the smaller combs the innermost spine is much smaller still, often quite aborted and apparently absent. The other spines are nearly equal in length, and both combs are uniform with one another in this respect. The combs are thickly webbed, and have large and elongate saccular extensions developed over the extremities of the spinelets.

The mouth-armature resembles that of *Retaster verrucosus*. The mouth-spines are eight to ten in number, four or five on each plate, both series being webbed together, and forming a narrow scoop-like fan. The secondary or superficial mouth-spines, one on each plate, are thin, cylindrical, not tapering, no longer than the mouth-spines, and covered with membrane.

The actino-lateral spines are of moderate length, reaching up to the margin of the test; they are hidden in membrane, of which a saccular but not indented prolongation extends beyond the extremities as a fleshy marginal fringe. The segmental apertures of the abactinal chamber are very large and elongate, situated well within the transverse combs, and quite hidden thereby.

Colour in alcohol, purplish grey.

Locality.—Station 149H. Off Cumberland Bay, Kerguelen Island. January 29, 1874. Lat. 48° 45′ 0″ S., long. 69° 14′ 0″ E. Depth 127 fathoms. Volcanic mud. Surface temperature 39°·8 Fahr.

Remarks.—*Retaster peregrinator* resembles in general form *Retaster verrucosus* from the Atlantic side of the Strait of Magellan, of which it may be regarded as the representative in the Southern Ocean area. The two forms are, however, specifically distinct, and

may be recognised readily by the structure of the paxillæ, the resultant character of the abactinal surface, and the armature of the adambulacral plates.

3. *Retaster gibber*, Sladen (Pl. LXXIV. figs. 5 and 6 ; Pl. LXXVII. figs. 7 and 8).

Retaster gibber, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 199.

Marginal contour substellate, interbrachial arcs acute, not rounded. Minor radial proportion about 50 per cent. R = 28 mm. ; r = 14 mm. Rays five, well rounded, tapering continuously from the angle to the extremity, with sides rounded, tumid, and curving over upon the actinal area as in *Echinaster*. Abactinal profile high, gibbous, rounded. On the actinal area the mouth and surrounding portions are deeply sunken.

The supradorsal membrane has reticulated fibrous bands, which mark it off into square or rhomboidal meshes of great regularity. In the centre of each, three or four paxillar spinelet-tips are visible ; and other spinelets radiate to the mesh fibres, one (or occasionally two) spiracula being situated in the interspaces. The white fibres of the meshes form a conspicuous feature, and the slightly protrusive tips of the spinelets impart a granulose appearance to the abactinal area, the whole being covered with a thin fleshy membrane. The oscular orifice is small, closed by a number of subpapillate spinelets, rather longer, more prominent, and more robust than those of the paxillæ proper.

The adambulacral furrows are narrow and deeply sunken. The combs of the adambulacral armature, which are quite within the furrow and below the level of the test, are composed of three to five spinelets, which are short, rather robust, and webbed together, the membrane being very slightly indented, and with a slight knob over the end of each spinelet. The ambulacral tube-feet are completely hidden by the over-arching combs.

The mouth-plates are deeply sunken ; the mouth-spines are longer than the spines of the adambulacral armature, three on each plate, the whole six being webbed together into a continuous comb. Each plate bears one large isolated secondary or superficial spine, longer than the mouth-spines, very robust, covered with a thick membrane, except at the tip, which is translucent and sharply pointed.

The segmental apertures are elongate and narrow, the papillæ being free on the aboral side only.

The actino-lateral spines are very short and robust, almost hidden within the furrow, of which they appear to form the sides, and only protrude a short way beyond the level of the test ; they stand nearly perpendicular to the plane of the ray, and in some parts show a tendency even to arch over the furrow slightly. This disposition, together with the abortive character of the fringe, imparts a feature very different from that usually presented by this structure in the Pterasteridæ. In the immediate angle, near the actinostome, the actino-lateral spines are somewhat longer, and are laid over upon the rounded surface of the interradial area, their web being continuous and forming a smooth, fleshy triangular area leading up to the mouth-angle.

Colour in alcohol, yellowish or greyish white.

Locality.—Station 311. Off the entrance to Smyth Channel. January 11, 1876. Lat. 52° 45′ 30″ S., long. 73° 46′ 0″ W. Depth 245 fathoms. Blue mud. Bottom temperature 46°·0 Fahr.; surface temperature 50°·0 Fahr.

Remarks.—*Retaster gibber* is distinguished from all other species of the genus by the rounded margin, by the shortness and peculiar posture of the actino-lateral spines, and by the character of the network of the supradorsal membrane.

4. *Retaster insignis*, Sladen (Pl. LXXVI. figs. 3 and 4; Pl. LXXVII. figs. 11 and 12).

Retaster insignis, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 200.

Marginal contour stellate, five-rayed. Interbrachial arcs well rounded. Minor radial proportion 44·4 per cent. R = 45 mm.; r = 20 mm. (In another example R : r as 70 : 31.) Rays very slightly tapering, obtusely rounded at the extremities. Abactinal surface moderately convex, rays uniformly rounded from the margin. Actinal surface flat or subconcave, somewhat impressed round the actinostome.

The supradorsal membrane is very conspicuously reticulated. The paxillæ-spinelets are prominent, arranged in regular lines, joined by fibres forming large uniform rhomboidal meshes, which are rendered still more distinct by the lines and the investment of the spinelets being of a dark purple or black colour, whilst the supradorsal membrane generally is ashy white. The meshes are filled in with a closely and regularly reticulate tissue, the interspaces of which are small, equally spaced, and each punctured with a minute spiraculum. The opposite angles of the rhomboidal areas are usually joined by fibres rather more robust than the rest, forming a right-angled cross in the centre, and marking off the reticulated area of the mesh into four more or less easily distinguishable sections. There are eighty to one hundred or more spiracula in each mesh. The spinelets which stand at the angles of the meshes protrude more than the others, and appear like well-developed thornlets springing from the general surface. The oscular orifice is small and constricted, the spinelets of the pseudo-valves are slightly prominent, their extremities being tipped with the same dark colour as the lines of reticulation above mentioned.

The ambulacral furrows are narrow, straight, and sunken, their apparent depth being further increased by the position of the prominent fringe of the actino-lateral spines, which stand vertically on each side of the furrow. The armature of the adambulacral plates consists of five spines, united together by a web, three standing on the margin of the plate parallel to the furrow, the next (more adoral) placed more outwards and away from the furrow, and the fifth more outward still. The innermost (*i.e.* most aboral) spine of the furrow series is very small, each succeeding one in the comb increasing in length; all are comparatively short, delicate, and tapering. The membrane which unites the spinelets is very fine, semi-transparent, and deeply festooned between the spinelets, and is continued from the outermost spine of the comb upon the adjacent actino-lateral spine. The small spines placed on the margin detract very slightly from the general transverse aspect of the comb, their smallness

rendering them inconspicuous; they have, however, the peculiarity of closing the space between their own and the next aboral comb at the margin of the furrow. The aperture-papillæ are small and sublanceolate in form, hidden in the general membrane, excepting their adoral side, which alone is free, and closes the aperture, shutting close up to the next aboral actino-lateral spine.

The mouth and parts surrounding it are much sunken—a feature further emphasised by the deep wall of the continuous marginal fringe. The mouth-plates are elongate, with their aboral extremities produced into a rather prominent peak, suggestive of that in *Hymenaster*. About five mouth-spines are borne on the outer margin of each plate, the innermost much longer and more robust than the others, all webbed together and forming an elegant marginal comb conformable to the contour of the plate. The innermost spines of the two adjoining plates stand close together, but are not united by web. On the superficies of each plate, and nearer the mouth than midway, is a long, robust, cylindrical, rapidly tapering secondary spine, standing isolate and perpendicular, covered with membrane, but with no web-attachments.

The actino-lateral spines are short and robust, not more than one-third longer than the outermost spine on the adambulacral plates, and tapering only very slightly. They are united by a close fibrous web, the margin of which and the tips of the spines (as well as the tips of the spinelets in the transverse adambulacral combs) are tipped with dark purple. The lateral fringe thus formed stands perpendicular on the margin of the furrow; and the spines comprising it would at first sight be thought to belong to the comb-series. The fringe of the adjacent sides of two neighbouring rays is merged together at their adoral extremity, forming a continuous fringe, which runs close past the aboral end of the mouth-plates.

Localities.—Station 189. In the Arafura Sea. September 11, 1874. Lat. 9° 36′ 0″ S., long. 137° 50′ 0″ E. Depth 25 fathoms. Green mud. Surface temperature 79°·0 Fahr.

Station 187. Off Booby Island, Torres Strait. September 9, 1874. Lat. 10° 36′ 0″ S., long. 141° 55′ 0″ E. Depth 6 fathoms. Coral mud. Surface temperature 77°·7 Fahr.

Remarks.—This remarkably handsome form may be distinguished at the first glance from all other species. In fact the superficial differences are so striking that I was at first disposed to accord it subgeneric rank; the structure of the supradorsal membrane, of the adambulacral armature, and of the actino-lateral fringe appearing to justify that step. Further study has, however, scarcely borne out the morphological importance which I was inclined to place upon these structures, and I now merely mention the circumstance as indicative of the characters by which the species may be readily distinguished.

Genus *Marsipaster*, Sladen.

Marsipaster, Sladen, Journ. Linn. Soc. Lond. (Zool.), 1882, vol. xvi. p. 202.

Form depressed. Marginal contour pentagonoid. Abactinal area flatly convex. Actinal area plane.

Supradorsal membrane an irregularly developed, somewhat spongiform, tissue. No muscular fibrous bands. No spicules. Paxillæ with moderately expanded crowns composed of a great number of fine, long, hair-like spinelets (fifteen to thirty), their extremities protruding freely through the membrane. Paxillæ invested with a well-developed membranous envelope.

Adambulacral armature forming transverse combs, consisting of spines webbed together; the spinelets more or less horizontal in position, overspanning the furrow.

Mouth-plates with one secondary or superficial spine on the actinal surface, connected with the mouth-spine series by a continuation of the web. Mouth-spines proper three on each plate, webbed together.

Actino-lateral spines merged in the actinal floor; no independent marginal fringe.

Remarks.—This genus is nearly related to *Pteraster*,—from which, however, it is distinguished by the rudimentary character of the supradorsal membrane, devoid of muscular fibrous bands; by the actino-lateral spines being merged in the actinal floor; and by the absence of a marginal fringe. Furthermore, the numerous hair-like spinelets of the paxillæ protruding through the supradorsal membrane give a peculiar character to the abactinal area; and the spines which constitute the armature of the adambulacral plates, from their high position in the furrow and from their more or less horizontal direction, present a feature unknown in the other members of the group.

The representatives of this genus collected by the Challenger are all from the Pacific; the occurrence of an Atlantic species is, however, reported by Perrier[1] in a summary of the novelties obtained by the "Talisman" Expedition, but no description has yet been published, and the position of the dredging station is not stated.

Chorology of the Genus Marsipaster.

α. *Geographical distribution:*—

Atlantic: One species between the parallels of 10° and 50° N.
Marsipaster alveolatus, dredged by the "Talisman" Expedition.

Pacific: Two species between the parallels of 30° and 40° S.
Marsipaster spinosissimus, in the Mid-South Pacific, near the meridian of 135° W. *Marsipaster hirsutus*, between Valparaiso and the Island of Juan Fernandez.

β. *Bathymetrical range:* 2160 to 2335 fathoms.

γ. *Nature of the Sea-bottom: Marsipaster spinosissimus* on Red clay; *Marsipaster hirsutus* on Blue mud.

[1] *Ann. Sci. Nat.* (Zool.), 1885, 6e Série, t. xix. Art. No. 8, p. 69.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Marsipaster alveolatus . .	Atlantic.	2192	...
Marsipaster hirsutus . .	Pacific.	2160	Blue mud.
Marsipaster spinosissimus .	Pacific.	2335	Red clay.

1. *Marsipaster spinosissimus*, Sladen (Pl. LXXVIII. figs. 5 and 6; Pl. LXXIX. figs. 7–9).

Marsipaster spinosissimus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 203.

Marginal contour pentagonoid. Rays somewhat produced. Interbrachial arcs widely rounded, forming a continuous curve from tip to tip. The minor radius is in the proportion of 62·5 per cent. R = 16 mm.; r = 10 mm. General form depressed; abactinal area slightly convex, tapering off gently to the extremity of the rays.

The supradorsal membrane is very fine and thin, somewhat irregular, and forming a continuous spongiose mass, rather than a definite membranous sheet, through which the spinelets of the paxillæ protrude freely. No specialised muscular fibrous bands are present. The spiracula, which are very few in number, are widely and irregularly spaced.

The paxillæ have long pedicles and a crown consisting of a great number of very fine hair-like spinelets (twenty to thirty at least upon the disk), which radiate at a small angle from the perpendicular, the crown and pedicle being alike invested with a delicate membranous tissue, the whole appendage seen in profile bearing a fanciful resemblance to an umbrella when turned inside out. The investing membrane merges into the general spongy tissue above mentioned, and a considerable length of the extremities of the spinelets protrudes free and naked. The paxillæ are numerous, and their crowns join up close together. Owing to these circumstances and to the great number of the spinelets, the abactinal surface presents the appearance of a coarse, irregular velvet pile. The oscular orifice is small and quite inconspicuous, the valves consisting of a flattened crown of rather more robust spinelets.

The ambulacral furrows are rather broad, not petaloid, and taper towards the extremity. The tube-feet are arranged in simple pairs. The armature of the adambulacral plates consists of five long, acicular spinelets, webbed together into transverse or obliquely curved combs, and remarkable for their position more than half within the furrow. The spines are of unequal length, the innermost being much smaller than any of the others, and placed somewhat in advance of, or aboral to, the series; the longest spine, which is

usually the middle one, or sometimes the second from the outside, is nearly equal in length to the breadth of the furrow, across which it stretches horizontally, whilst the two outer spines radiate downward and aborally. Consequent on this position of the median spine, the spinelets which compose the outer half of the comb radiate very widely apart. The connecting web is fine and semitransparent, very deeply indented between the spinelets, which gives the combs a remarkable appearance; and the web is continued from the outer spine of the comb down to the base of the aperture-papilla, and not out along the actino-lateral spine. The aperture-papilla, which is represented by a small conical spinelet placed on the outer edge of the adambulacral plate, and between the bases of the actino-lateral spines, is covered with membrane, that of the actinal area being stretched over it, giving it the form of a small subtriangular or conical peak.

The mouth-plates are of moderate length, with widely expanded lateral flanges. The keel along the line of junction, which is prominent, forms a well-developed peak aborally, hidden beneath the tissue of the actinal membrane, and is produced into a point adorally. On each side of this, and placed on the horizontal margin of the plates, are three mouth-spines, webbed together, about equal in size to the spines of the adambulacral armature, but rather more robust, the innermost spine on each plate being the longest, and the other two decreasing in series. Immediately behind the three mouth-spines stands a small secondary or superficial mouth-spine about the same size as, or smaller than, the innermost mouth-spine, with which it is connected by a continuation of the web; the pseudo-comb being thus bent upon itself at a sharp angle, gives a very striking character to the armature of the mouth-plates. The spines which form the armature of the first adambulacral plates have their bases arranged in a semicircular curve, and the spines radiate at equal distances apart, and are directed downward and adorally, the middle spine being longest. The spines are all webbed together, and a continuation of the tissue from the outermost spine is attached to the prominent posterior or aboral portion of the median keel of the mouth-plates, and there coalesces with the web of the corresponding comb of the neighbouring ray, thus forming an elegant compound pair of fans which arch over the aboral peak of the pair of mouth-plates.

The actino-lateral spines are rather short and robust, not extending, or only to the very slightest distance, beyond the margin. They are united by a fine semitransparent membrane, slightly indented between the tips, which also forms the actinal floor of the test. Probably in this species there is no free extension of the lateral or marginal fringe, such as occurs in shallower water forms, but unfortunately the preservation of the specimens in this portion of their structure is imperfect; for the same reason it is difficult to determine with accuracy the number of actino-lateral spines, but probably about twenty to twenty-two were present; seventeen may be counted in natural position; the sixth from the mouth appears to have been the longest.

Colour in alcohol, brownish grey.

Locality.—Station 286. In the Mid-South Pacific, near the meridian of 135° W., approximately midway between Sydney and Valparaiso. October 16, 1875. Lat. 33° 29′ 0″ S., long. 133° 22′ 0″ W. Depth 2335 fathoms. Red clay. Bottom temperature 34°·8 Fahr.; surface temperature 63°·0 Fahr.

2. *Marsipaster hirsutus*, Sladen (Pl. LXXVIII. figs. 3 and 4; Pl. LXXIX. figs. 4–6).

Marsipaster hirsutus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 205.

Marginal contour substellate, interbrachial arcs well indented, the minor radius being in the proportion of 60·2 per cent. R = 13·5 mm.; r = 8·5 mm. Rays broad at the base, bounded by lines running direct from the median interradial line, with little if any curve or rounding. Abactinal area moderately convex; rays slightly upturned at the extremities.

The supradorsal membrane is a fine, irregular, and somewhat spongiose tissue continuous over the whole area, through which the extremities of the spinelets of the paxillæ protrude freely. No definite membrane, and no muscular fibrous bands are present. The paxillæ have long robust pedicles and bear ten to fifteen fine, long, acicular spinelets; the investing membrane of the crown is merged into the general supradorsal tissue, and the naked tips of the spinelets, which pass through the tissue, give the surface a somewhat hirsute or prickly appearance. The spiracula are comparatively large, very few in number, and very widely spaced. The oscular aperture is inconspicuous; the valves are formed of spines similar to those on the paxillæ generally, and present no special external characters.

The adambulacral furrows are broad and straight, not petaloid. The tube-feet are arranged in simple pairs. The armature of the adambulacral plates consists of five spinelets, which form a transverse comb. The two innermost spines are much smaller than the rest, and stand parallel to the furrow, rather in advance of, or aboral to, the other three, which are disposed across the broad adambulacral plate, are articulated on more or less definite tubercles, and form a series at a right angle to the furrow. The middle spine is longest. The whole series is webbed together with membrane which is deeply indented between the radiating spinelets, but not nearly so much as in *Marsipaster spinosissimus*.

The mouth-plates are broad, having wide lateral expansions, and with an elevated ridge along their line of junction, developing a prominent peak aborally and a rounded point inward. The armature consists of three long, robust mouth-spines, placed on the horizontal margin of each plate, the innermost spine being largest and longer than the spinelets of the adambulacral armature, the outermost less than half its size, and sometimes accompanied by an additional diminutive spinelet. The inner spines stand well away

from the adoral point of the united mouth-plates, which becomes in consequence rather conspicuous. Immediately behind, or aboral to the mouth-spines proper, is a single superficial or secondary mouth-spine, smaller than the long mouth-spines. The three mouth-spines of each plate are webbed together by a semitransparent membrane deeply indented between; and the secondary spine is united to the innermost spine by a continuation of the web. The long innermost spines are directed towards the centre of the mouth, where they almost meet, the other spines radiating slightly outward from this. The first, or most adoral, comb-series forms a widely expanded semicircular fan, the web being continued and attached to the prominent aboral peak of the mouth-plates.

The actino-lateral spines are robust, but short; the character of the fringe is destroyed, but probably was more or less distinct along the rays; the spines do not reach to the margin in the interbrachial arc, but are merged in the membrane of the actinal floor. The margins of the rays and disk are well-rounded and regularly covered with the intrapaxillar tissue continuous from the disk; indeed the greater part of the actinal portion of the interradial space has the paxillate character of the abactinal surface.

Locality.—Station 299. Off the western coast of South America, between Valparaiso and the Island of Juan Fernandez. December 14, 1875. Lat. 33° 31′ 0″ S., long. 74° 43′ 0″ W. Depth 2160 fathoms. Blue mud. Bottom temperature 35°·2 Fahr.; surface temperature 62°·0 Fahr.

Genus *Calyptraster*, Sladen.

Calyptraster, Sladen, Journ. Linn. Soc. Lond. (Zool.), 1882, vol. xvi. p. 207.

Form depressed. Marginal contour pentagonal. Abactinal area plane. Actinal area convex.

Supradorsal membrane very delicate, perfectly transparent. No muscular fibrous bands. Spiracula present. No spicules. Paxillæ with short, robust spinelets (five or six in the type species), usually flaring at the extremity, crown widely expanded, not protruding through, or even elevating the membrane, simply supporting it.

Adambulacral armature forming transverse combs of spines; the spinelets being perpendicular in position, and webbed together. Segmental apertures present. Aperture papillæ not free, opening laterally only.

Mouth-plates with two or three pairs of superficial or secondary mouth-spines on the actinal surface of the plates. Mouth-spines proper two, or occasionally three.

Actino-lateral spines merged in the actinal floor. No independent lateral fringe.

Remarks.—This genus is established for the reception of a very elegant little form which presents certain resemblances to *Hymenaster* and also to *Pteraster*. It resembles *Hymenaster* in the absence of a marginal fringe and in the merging of the actino-lateral spines in the actinal floor, and resembles *Pteraster* in having the armature of the adam-

bulacral plates composed of transverse combs of spines united by web-tissue. It differs from both genera in its transparent supradorsal membrane devoid of muscular fibrous bands, by the possession of three pairs of free secondary or superficial mouth-spines, and by its true pentagonal form.

Chorology of the Genus Calyptraster.

α. Geographical distribution :—

ATLANTIC : One species between the parallels of 0° and 15° S.

Calyptraster coa, off the coast of Brazil, south-east of Pernambuco.

β. Bathymetrical range: Uncertain ; between 32 and 400 fathoms.

γ. Nature of the Sea-bottom: Red mud.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Calyptraster coa . . .	Atlantic.	32 to 400	Red mud.

1. *Calyptraster coa*, Sladen (Pl. LXXVIII. figs. 1 and 2 ; Pl. LXXIX. figs. 1–3).

Calyptraster coa, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 207.

Marginal contour pentagonal, interbrachial arcs very slightly incurved. Minor radial proportion 68 per cent. R = 11 mm. ; $r = 7{\cdot}5$ mm. Abactinal surface flat, or even somewhat concave in consequence of the rays being slightly curved upward ; radial areas not specialised externally, the supradorsal membrane forming a plane area. No marginal fringe. Actinal surface convex.

The supradorsal membrane is extremely thin and perfectly hyaline, a clean specimen appearing to the eye as transparent as glass. No muscular bands are present, although a fibrillar structure may be seen in the tissue under high magnification. The spiracula are rather large, numerous, and uniformly distributed. The paxillæ have long pedicles, and are moderately delicate, evenly and equidistantly placed ; the crown is usually composed of five spinelets, which are short in comparison with the pedicle, and rather delicate. A few of the spinelets taper a little at their extremity, but usually they are slightly flaring.

The supradorsal membrane is literally supported upon the tips of these spinelets. About nine longitudinal rows of paxillæ-crowns are discernible at the base of a ray. The oscular orifice is small but very conspicuous, in consequence of the well-defined bosses upon which the valves are articulated, which are visible through the transparent membrane. The valves are very regular, and composed of thirteen or fourteen spines, the outer one or two on each side being almost aborted and hidden in the general membrane by which the whole series is webbed together, whilst the two innermost spines are longer than the others, which decrease gradually on each side and form a regular triangular fan, the base of which is articulated on the elongate boss or modified pedicle above-mentioned. The bosses stand transversely and regularly central in the median line of each ray; in consequence of their breadth the distance between two neighbouring bosses, which is very small, is bridged over by two or three spinelets, whilst a few short spinelets spring from the surface of the boss, and in this manner mark out a pentagonal outline round the orifice. The valves when closed lie flat over the opening, and do not form a pyramid.

The ambulacral furrows are wide, lanceolate, and scarcely petaloid. The armature of the adambulacral plates consists of four spines (in a small specimen three), which are of moderate length, rather robust at the base and sharply tapering, arranged at an angle of such great obliquity that, roughly speaking, the series may be described as transverse, although the innermost spine, which is somewhat smaller than the others, is usually more aboral than the rest of the series. The spines are not individually invested with membrane, but are webbed together in the combs on at least the inner half of the ray. The web-tissue is extremely thin and very deeply indented between the spinelets; indeed, it is only possible to make it out by means of favourable illumination. This character seems to be less general in some specimens than in others.

The aperture-papillæ are small, short, and elongately oval, more or less squamous, but often developing small thornlets upon the surface. They are more or less hidden in membrane, and are free only on the aboral side.

The mouth-plates are small, but rather elongate and prominent, as if compressed together laterally. The aboral extremity is prominent. The adoral peak is almost obliterated by the expansion of the lateral flanges. Each plate bears three superficial or secondary spines (in a small specimen two) not longer than the spines of the adambulacral armature, but nearly twice as robust, thick at the base and tapering to a fine extremity. They are somewhat bowed or geniculate at right angles to the line of junction to the mouth-plate. The anterior pair are situated at a little distance from the adoral extremity of the plates; and the second pair, which are slightly larger and rather wider apart, stand midway between them and the aboral extremity of the mouth-plates. Immediately above the anterior pair and placed on the innermost part of the lateral flanges, are a pair of mouth-spines (*i.e.*, one on each plate), similar in every respect to the secondary spines just described, only slightly

smaller and rather wider apart; indeed, in some specimens one is almost inclined to class them along with the secondary series. Midway on the horizontal margin of the flange is one small pointed mouth-spine; and in a large specimen a second and rather larger spinelet occurs between this and the innermost mouth-spine, and nearer to the latter.

The actino-lateral spines are rather robust, well spaced, tapering slightly at the tips, excepting those spines included within the interradial area, which are slightly thickened, and do not meet their corresponding spines from the neighbouring ray in the median interradial line. There are twenty-five to twenty-seven actino-lateral spines on each side of a furrow, the seventh or eighth from the mouth being longest; after this they gradually diminish in size as they proceed outward, maintaining, however, a fair length even at the extremity, where they are a little shorter than the first (or adoral) spine of the series, thus forming a conspicuous little fringe round the extremity of the ray. The ambulacral furrow is extended vertically up the extreme tip of the ray, but is not exposed on the abactinal surface, being arched over by the terminal spinelets just described. Immediately inside this ocular fringe on the abactinal surface is a little ridge of eight to ten minute conical spinelets or papillæ, which forms a semi-circular collaret at the extreme tip.

The actinal membrane is as transparent as the abactinal membrane, the actino-lateral spinelets forming the floor of the test and projecting only their pointed tips beyond the sharp margin, to which they impart a delicate serrate character.

Colour in alcohol, a light straw colour verging towards golden brown.

Locality.—Station 122–122c. Off the coast of Brazil, south-east of Pernambuco. September 10, 1873. Lat. 9° 5′ 0″ S. to 9° 10′ 0″ S., long. 34° 49′ 0″ W. to 34° 53′ 0″ W. Depths 32, 120, 350, 400 fathoms. Red mud. Surface temperature 77°·5 Fahr.

Unfortunately only the Station number is indicated on the label accompanying these specimens, and no record is given as to the particular dredging in which they were obtained.[1]

Genus *Hymenaster*, Wyville Thomson.

Hymenaster, Wyville Thomson, The Depths of the Sea, London, 1873, p. 120.

This genus was established by Sir Wyville Thomson for the reception of a remarkable Asterid discovered during the cruise of H.M.S. "Porcupine." Only a single example was obtained, and, although the form was not fully described, the characters which distinguish it from *Pteraster* were duly recognised and a good figure of the actinal aspect of the starfish was given by Sir Wyville Thomson. Some doubts were subsequently expressed by Perrier[2] as to the validity of separating *Hymenaster* from *Pteraster*, but

[1] From an examination of our Station notes I have no doubt the specimens came from the trawling in 350 fathoms.—*Ed.*

[2] *Nouv. Archives Mus. Hist. Nat.* 1878, 2e Série, t. i. p. 55.

in his later work[1] the independence of the genus is recognised, and two new species dredged during the "Talisman" Expedition have been referred by him to *Hymenaster* and "named," but their descriptions have not yet been published.

The dredgings of the Challenger Expedition have now shown that *Hymenaster* possesses a world-wide distribution in deep waters, and that the genus exhibits a remarkable amount of morphological plasticity, no less than twenty-four species being now known.

The bathymetrical range of the genus is also remarkable, as, with the exception of the type form (*Hymenaster pellucidus*), which ranges from 70 to 1539 fathoms (*fide* Danielssen and Koren), all the species are confined to the Abyssal zone. One, *Hymenaster infernalis*, extends to 2900 fathoms, the greatest depth at which starfishes have hitherto been found; and four other species occur in depths greater than 2000 fathoms.

The character of the adambulacral armature, which does not form transverse combs of webbed spines, and the structure of the actinal skeleton, composed of greatly developed actino-lateral spines, overlaid with a membranous tissue, forming the whole actinal floor of the test, constitute differences which, in my opinion, emphatically separate *Hymenaster* generically from *Pteraster;* and its divergence from the other members of the family Pterasteridæ is equally well marked.

The general facies of the type appears to be one of great antiquity. This, however, is not the place to discuss, as I should desire, the archaic relationships of existing Asterids; and I would therefore now only briefly direct attention to the remarkable resemblance and, in many respects, apparent similarity of general character, which exist between *Hymenaster* and the recently described *Loriolaster* of Stürtz[2] from the Lower Devonian slates of Bundenbach.

Chorology of the Genus Hymenaster.

a. *Geographical distribution:—*

ATLANTIC: Seven species between the parallels of 81° N. and 40° S.

Hymenaster pellucidus, from the Faeröe Channel, off the coast of Norway, and the islands of Jan Mayen and Spitzbergen. **Hymenaster membranaceus*, south-west of Cape Finisterre. *Hymenaster rex* and *Hymenaster giboryi*, dredged by the "Talisman" Expedition. **Hymenaster anomalus*, north of the Island of Tristan da Cunha. *Hymenaster modestus*, off the coast of the United States of North America. **Hymenaster pergamentaceus*, off the coast of South America, east of Buenos Ayres.

[1] *Ann. Sci. Nat.* (Zool.), 1885, 6e Série, vol. xix. Art. No. 8, p. 69.

[2] *Palæontographica*, 1886, Bd. xxxii. p. 94. Taf. xii., xiii.

Southern Ocean: Nine species between the parallels of 40° and 60° S.

**Hymenaster graniferus*, **Hymenaster coccinatus*, and **Hymenaster præcoquis*, in the neighbourhood of Marion and the Crozet Islands. **Hymenaster latebrosus*, near the meridian of 110° E. **Hymenaster nobilis*, **Hymenaster formosus*, **Hymenaster sacculatus*, **Hymenaster cælatus*, and **Hymenaster crucifer*, south of Australia.

Pacific: Eight species between the parallels of 40° N. and 40° S.

**Hymenaster infernalis*, from the Mid-North Pacific, near the meridian of 170° E. **Hymenaster glaucus*, south of Japan. **Hymenaster pullatus*, north of New Guinea, south-west of the Admiralty Islands. **Hymenaster echinulatus* and **Hymenaster geometricus* in the Mid-South Pacific near the meridian of 135° W. **Hymenaster carnosus*, off the west coast of South America. **Hymenaster vicarius* and **Hymenaster porosissimus*, off the coast of South America, between Valparaiso and the Island of Juan Fernandez.

β. *Bathymetrical range:* 70 to 2900 fathoms.

Greatest range of one species: *Hymenaster pellucidus*, 70 to 1539 fathoms (*fide* Danielssen and Koren).

All the species excepting *Hymenaster pellucidus* are confined to the Abyssal zone. Five species, *Hymenaster pergamentaceus*, *Hymenaster echinulatus*, *Hymenaster infernalis*, *Hymenaster geometricus*, and *Hymenaster giboryi*, occur in depths greater than 2000 fathoms. *Hymenaster infernalis* extends to 2900 fathoms, the greatest depth at which Asterids were dredged by the Challenger.

γ. *Nature of the Sea-bottom:* The majority of the species are found on Globigerina ooze, viz., *Hymenaster nobilis*, *Hymenaster formosus*, *Hymenaster sacculatus*, *Hymenaster carnosus*, *Hymenaster vicarius*, *Hymenaster cælatus*, *Hymenaster crucifer*, *Hymenaster porosissimus*, *Hymenaster graniferus*, *Hymenaster coccinatus*, and *Hymenaster præcoquis;* the last is also found on Diatom ooze. *Hymenaster latebrosus* is found on Diatom ooze. *Hymenaster pergamentaceus*, *Hymenaster pullatus*, and *Hymenaster membranaceus* frequent Blue mud. *Hymenaster echinulatus*, *Hymenaster infernalis*, and *Hymenaster geometricus* live on Red clay. *Hymenaster glaucus* is found on Green mud. *Hymenaster anomalus* on Pteropod ooze. *Hymenaster pellucidus* is found on Biloculina clay, sandy clay, and Blue clay.

The species dredged by the Challenger are indicated in the above list by an asterisk.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Hymenaster anomalus	Atlantic.	1425	Pteropod ooze.
Hymenaster cælatus	Southern.	1800	Globigerina ooze.
Hymenaster carnosus	Pacific.	1500	Globigerina ooze.
Hymenaster coccinatus	Southern.	1375	Globigerina ooze.
Hymenaster crucifer	Southern.	1800	Globigerina ooze.
Hymenaster echinulatus	Pacific.	2335	Red clay.
Hymenaster formosus	Southern.	1800	Globigerina ooze.
Hymenaster geometricus	Pacific.	2335	Red clay.
Hymenaster giboryi	Atlantic.	2214	...
Hymenaster glaucus	Pacific.	565	Green mud.
Hymenaster graniferus	Southern.	1375	Globigerina ooze.
Hymenaster infernalis	Pacific.	2900	Red clay.
Hymenaster latebrosus	Southern.	1950	Diatom ooze.
Hymenaster membranaceus	Atlantic.	1125	Blue mud.
Hymenaster modestus	Atlantic.	1098 to 1451	...
Hymenaster nobilis	Southern.	1800	Globigerina ooze.
Hymenaster pellucidus	Atlantic.	70 to 1539	Clay (various kinds).
Hymenaster pergamentaceus	Atlantic.	2650	Blue mud.
Hymenaster porosissimus	Pacific.	1375	Globigerina ooze.
Hymenaster præcoquis	Southern.	1375 to 1600	Globigerina ooze. Diatom ooze.
Hymenaster pullatus	Pacific.	1070	Blue mud.
Hymenaster rex	Atlantic.	601 to 1093	...
Hymenaster sacculatus	Southern.	1800	Globigerina ooze.
Hymenaster vicarius	Pacific.	1375	Globigerina ooze.

Synopsis of the Species included in the Genus Hymenaster.

A. Adambulacral armature consisting of one spinelet.

a. Paxillæ-crowns forming raised areas of membrane. Spiracula small, numerous, equidistantly spaced . . . . . *nobilis.*

b. Paxillæ-crowns not forming raised areas.

a. Spiracula single, large, uniformly spaced . . . . . *formosus.*

b. Spiracula in groups of six to ten, small, irregularly distributed . *pergamentaceus.*

B. Adambulacral armature consisting of two spinelets.

a. Muscular fibrous bands of supradorsal membrane coherently reticulated.

a. Paxillæ-crowns forming definite areas. Spinelets not prominent . *sacculatus.*

b. Paxillæ-crowns not forming definite areas. Spinelets very prominent.

α. Spinelets forming a raised keel over each radius. Spiracula large, single, distributed . . . . . *echinulatus.*

β. Spinelets not forming a raised keel. Spiracula microscopic, in groups of ten or more . . . . . *carnosus.*

b. Muscular fibrous bands of supradorsal membrane simply intercrossing.

a. Radial areas elevated in relief above the interradial tissue. Paxillæ with three spinelets . . . . . *glaucus.*

b. Radial areas not elevated above the interradial tissue. Paxillæ with more than three spinelets.

α. Rays broad. Aperture-papillæ simple.
1. Interbrachial arcs indented, defining broad lanceolate rays. Spiracula numerous, large and conspicuous. Spinelet-tips very prominent . . *vicarius.*
2. Interbrachial arcs not indented; form pentagonoid. Spiracula few, small and inconspicuous. Spinelet-tips not prominent . . . . . *pellucidus.*

β. Rays attenuate. Aperture-papillæ comb-like . . . *infernalis.*

C. Adambulacral armature consisting of three spinelets.
a. Muscular fibrous bands close, subdiffused, coherently reticulated.
α. Paxillæ-crowns forming definite areas in relief.
α. Paxillar elevations closely crowded. Spiracula uniformly distributed, not in lines . . . . . *cælatus.*
β. Paxillar elevations widely spaced. Spiracula confined to interspaces, arranged in lines . . . . . *crucifer.*
b. Paxillæ-crowns not forming definite elevated areas.
α. Spines of the adambulacral armature partially webbed. Three pairs of secondary mouth-spines . . . *anomalus.*
β. Spines of the adambulacral armature not webbed. Two pairs of secondary mouth-spines.
1. Meshes of supradorsal membrane irregular and not uniform. Spines of the adambulacral armature unequal . . . . . *latebrosus.*
2. Meshes of supradorsal membrane small and uniform. Spines of the adambulacral armature equal . *porosissimus.*
b. Muscular fibrous bands fine, definite, widely spaced, simply intercrossing.
α. Supradorsal membrane with granular bodies . . . . . *graniferus.*
b. Supradorsal membrane devoid of granular bodies.
α. Spines of the adambulacral armature long and needle-shaped *geometricus.*
β. Spines of the adambulacral armature short and compressed.
1. Muscular fibres very numerous in supradorsal membrane. Web of the actinal floor with cross muscular fibres. Longest actino-lateral spine the 12th . *pullatus.*
2. Muscular fibres not very numerous in supradorsal membrane. No muscular fibres in the web of the actinal floor. Longest actino-lateral spine the 17th *membranaceus.*

D. Adambulacral armature consisting of more than three spinelets.
a. Three or four spinelets in the adambulacral armature. Aperture-papillæ five to seven rayed, comb-like, large. One pair of secondary mouth-spines *coccinatus.*
b. Three to five spinelets in the adambulacral armature. Aperture-papillæ simple, small and dumpy. Two or three pairs of secondary mouth-spines . *præcoquis.*

1. *Hymenaster nobilis*, Wyville Thomson (Pl. LXXXVII. figs. 1–3).

Hymenaster nobilis, Wyville Thomson, 1876, Journ. Linn. Soc. Lond. (Zool.), vol. xiii. p. 73, fig. 11; Voy. of Challenger, Atlantic, vol. ii. p. 238, fig. 48.

Marginal contour pentagonal, interbrachial arcs very slightly indented, the margin forming a continuous curve of small degree from tip to tip. Rays not produced, and tapering very slightly beyond the natural angle of a pentagon. The minor radius is in

the proportion of 71 per cent. R = 138 mm.; r = 98 mm. General form much depressed, slightly elevated in the centre of the abactinal area. Radial areas very conspicuously defined, the paxillæ-spinelets being exclusively confined to those areas, which consequently appear to stand at a higher level than the wide interradial areas, which are destitute of spinelets and covered with a thick fleshy membrane. Actinal surface flat, the margins of the ambulacral furrows being rather tumid or convex.

The supradorsal membrane is comparatively thin over the radial areas and rather parchment-like in appearance. The paxillæ usually bear three spines, which are long, prominent, and arranged in triangles. Each spinelet raises the membrane into a sharp conical elevation, each maintaining its individuality, the subtriangular area in the centre of the paxillæ-crown remaining, however, more or less elevated above the general level. The paxillæ are arranged in regular longitudinal lines along the rays, three on each side of the median line, which is left free. The spinelets that compose the crowns are likewise remarkably uniform in disposition, two standing aboral to the third, which is opposite to their interspace; the base of the triangular crown-area thus formed is consequently at right angles to the median line of the ray, and the apex is directed adorally. In the outermost row, however, on each side of a ray, this arrangement is more or less modified in consequence of lateral compression of the paxillæ-crowns,—these being more compact and with the spinelets less regular in their disposition. The oscular orifice is large and very conspicuous, and the valves are composed of about a dozen moderately long, rather fine spinelets, all of which are webbed together; the valves expanding fan-like when open form a prominent vertical wall to the orifice. The spiracula are small, very numerous, closely and equidistantly placed, occupying the whole interspace between adjacent paxillar-crowns. Very remarkable elongated tracts or lines of spiracula and an accompanying wrinkled membrane extend from the paxilliferous radial areas out upon the fleshy interradial membrane, which has the appearance of being inlaid with them. These lines are slightly curved, nearly equal in length to the half of the radial area, placed regularly parallel to one another, and directed at an angle inward in relation to the direction of the ray.

The ambulacral furrows are broad, almost straight, and very slightly petaloid. The tube-feet are large and robust, arranged in simple pairs. The armature of the adambulacral plates consists of one rather short spinelet, invested with a wide membrane which extends beyond the tip as a saccular prolongation twice as long as the spinelet itself. The aperture-papillæ are large, fleshy, subspatulate or oval, occupying nearly the whole space between the bases of the actino-lateral spines.

The mouth-plates form a broad rounded ridge at their line of junction, prominent aborally. Each plate bears one short secondary or superficial spine, with a wide investing sacculus, placed about midway on the surface of the plate, quite behind the mouth-spines, the pair being very widely separated. The mouth-spines, which are three in number, are

short, conical, placed on the margin of the lateral flange of the plate, and have saccular investments.

The actino-lateral spines, which are about forty-five in number on each side of the furrow, are hidden in the thick fleshy tissue, and shallow channels or wrinkles traverse the membrane between each spine, which give a fluted appearance to the interradial area on the under side of the starfish. The longest spines are little more than the extreme breadth of the ambulacral furrow,—a wide space, greater at the margin than the length of the spines themselves, intervening in the interradial area between their extremities and those of the spines of the neighbouring ray. The spines are directed slightly backward (*i.e.*, adorally in relation to the direction of the ray); and the series of those spines whose extremities terminate in the ray-margin diminish very rapidly in length.

Colour in alcohol, abactinal surface greyish white, tinged with purple on the radial areas, the interradial areas and fringe being purplish grey. Actinal surface livid purple. Ambulacral tube-feet yellowish grey.

Locality.—Station 158. South of Australia, 1099 miles south-west of Cape Otway. March 7, 1874. Lat. 50° 1′ 0″ S., long. 123° 4′ 0″ E. Depth 1800 fathoms. Globigerina ooze. Bottom temperature 33°·5 Fahr.; surface temperature 45°·0 Fahr.

Remarks.—This species, which is by far the largest *Hymenaster* known, is distinguished by the single spinelet on the adambulacral plates, by the raised areas of the paxillæ-crowns, and by the small, numerous, and equidistantly spaced spiracula. In the specimen above described, Sir Wyville Thomson[1] states that "there were one or two eggs in the pouch; but they were apparently abortive. It seemed that the brood had been lately discharged; for some oval depressions still remained on the floor of the central chamber, in which the eggs or the young had evidently been lodged. I have on three occasions found the eggs beneath the membrane in the angles of the arms, and, in a more advanced stage, congregated in the central tent, but never under circumstances such that I could keep and examine them; exposed or loosely covered eggs or embryos, or any soft and pulpy organs or appendages are always in a half disintegrated state when they are brought up from such great depths, if they are not entirely washed away."

2. *Hymenaster formosus*, Sladen (Pl. LXXXI. figs. 3 and 4; Pl. LXXXIII. figs. 4–6).

Hymenaster formosus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 213.

Marginal contour subpentagonal, interbrachial arcs very slightly indented, the minor radius being in the proportion of 73·6 per cent. R = 19 mm.; $r = 14$ mm. General form depressed, abactinal area rising slightly conoid in the centre. Radial areas not specially defined although to a certain extent indicated, the paxillæ-spinelets being confined to the rays and not encroaching on the median interradial portion of the membrane. Marginal fringe very narrow, faintly crenulated, tips of spines rounded and thickened.

[1] *Journ. Linn. Soc. Lond.* (Zool.), vol. xiii. p. 75; Voy. of Challenger, vol. ii. p. 239.

The supradorsal membrane is semitransparent, with closely and regularly reticulated fibrous bands, the bands (which are robust and massively coherent) forming definite meshes over the entire area. The disposition of the tendons is not in any definable relation to the spinelets. Each mesh is filled up with a fine transparent tissue, in the centre of which is a single large spiraculum, surrounded by a conspicuous white ring. Consequent on the number and regularity of the meshes, the whole area is closely and uniformly covered with spiracula.

The paxillæ are few in number and bear from three to five (or more) robust spinelets, which are well expanded and distributed pretty uniformly over the area, excepting the median interradial areas. The rounded tips of the spinelets do not protrude, but simply elevate the supradorsal membrane into little rounded tubercles, which rise directly from the surface like warts, and, owing to their somewhat sparse distribution, impart a very characteristic appearance to the abactinal area of the starfish. Over the median portion of the rays and towards their extremities the tubercles are very much smaller in size and are more closely placed. A conspicuous subpentagonal ring of tubercles surrounds the centre of the disk at the base of the valves of the oscular orifice, the spinelets of fifteen paxillæ contributing to its formation. The paxillæ stand at the base of each valve, one forming the actual support of the valve, and the other two being placed external to this, one on each side. Usually two of the spinelets of each of the outer pairs of paxillæ radiate outward and produce a very striking appearance on the abactinal area, as their whole outline and method of arrangement are perfectly discernible in consequence of the semitransparency of the membrane. The oscular orifice is of moderate size, the valves being subregular and closely reticulated.

The ambulacral furrows, which are narrow, are more or less uniform in breadth except at the extremity, where they taper rapidly, and near the actinostome, where they are also constricted. The armature of the adambulacral plates consists of only one spinelet to each plate, which is comparatively long and cylindrical, and invested with membrane which develops a more or less extended sacculus at the extremity. The aperture-papillæ are elongate, not tapering, nearly uniform in breadth, rounded at the extremity, almost as long as the spinelets on the adambulacral plates, and presenting a robust appearance in consequence of the investing membrane.

The mouth-plates are comparatively small, short, and inconspicuous; and the small secondary or superficial spine which stands on the median portion of each plate is moderately long and robust. The rest of the armature is indeterminable without damaging the specimen, in consequence of the extrusion of the stomach and other organs.

The actino-lateral spines are regular and delicate, the twelfth from the mouth being longest. The spines preceding this one do not meet in the median interradial line, but are separated from those of the neighbouring ray by a uniformly narrow space, across which muscular fibres pass from side to side, uniting the tips of the corresponding spines on the

two sides. The tissue of the lateral web is thickened along the margin, especially over the extremity of each spine, to which it gives a rounded capitate appearance, the web having the very faintest trace of incurving between the spinelets. The thickening of the membrane just mentioned is much more pronounced in the arm-angle, where all indentation of the web is obliterated and indications are present of a tendency to excrescent growth. A further faint line of thickening can be made out at the union of the abactinal and actinal tissues, which occurs just within the margin, especially round the shaft of the spines.

Colour in alcohol, greyish white.

Locality.—Station 158. South of Australia, 1099 miles south-west of Cape Otway. March 7, 1874. Lat. 50° 1′ 0″ S., long. 123° 4′ 0″ E. Depth 1800 fathoms. Globigerina ooze. Bottom temperature 33°·5 Fahr.; surface temperature 45°·0 Fahr.

Remarks.—*Hymenaster formosus* may be recognised at once by the small, uniform, rounded, and almost wart-like elevations on the abactinal surface; and by the single, large, and uniformly spaced spiracula—a character which readily distinguishes it from the other species having only one spine in the adambulacral armature.

3. *Hymenaster pergamentaceus*, Sladen (Pl. LXXXI. figs. 1 and 2; Pl. LXXXIII. figs. 1–3).

Hymenaster pergamentaceus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 215.

Marginal contour stellato-pentagonal; interbrachial arcs moderately indented, although the actual angle is masked by an abnormal development of the actino-lateral spines, which meet there and form a peak and an irregular excrescence of the web. The minor radial proportion is about 60·5 per cent. R = 66 mm.; r = 40 mm. (approximately). The radial areas are well defined from the lateral fringe, and taper rapidly at the extreme tip to a fine, slightly produced extremity, which is recurved. The "fringe" is more or less irregular, owing to the thickening at the margin and abnormal growth, and is only slightly indented or festooned between the spinelets, the tips of which are rounded and thickened.

The supradorsal membrane is thin, smooth, and vellum-like. The paxillæ are comparatively few in number and bear five to eight spinelets, which are robust and widely expanded. Although these are in a certain sense regular in their distribution over the area, no definite pattern of arrangement is produced. The extremities of the spinelets do not protrude through the membrane, but simply elevate it into small eminences; and owing to the thinness of the supradorsal membrane, the outlines of the spinelets which form each paxilla may be more or less clearly discerned. The rays are well defined, and no paxillæ-spinelets occur in the intermediate interradial portion of the lateral fringe, nor do any spinelets encroach upon a narrow clear space which runs down the median line of each radius. The fibrous bands are very numerous and closely massed together;

indeed so great is their development that nearly all individuality of fascicular character is obliterated, and they appear to form a compact muscular tissue. In certain lines, however, along the sides of the rays there seems to be a tendency towards a greater and more definite development of fibres in a lineal direction, parallel to the median line of the ray. The spiracula are very few in number, quite microscopic, and occur in little groups of six to ten which are widely and irregularly distributed. The oscular orifice is large, the valves when closed forming a cone of small elevation; and the spines which compose them are somewhat irregular both in number and gradation in size.

At the base of each valve is a rather close aggregation of paxillæ whereby a more or less complete annulus is formed around the orifice; and from each of the five groups in question proceed a number of spinelets, which radiate outward from the centre and constitute a conspicuous feature.

The ambulacral furrows are very wide, subpetaloid, tapering to a fine extremity, and constricted slightly near the actinostome. The armature of the adambulacral plates consists of only one spine to each plate, which is long, cylindrical, tapering to a fine point, and placed on a small process projecting into the furrow. The aperture-papillæ are elongate, covered with a very widely expanded membrane, imparting an acumino-spatulate form.

The mouth-plates are long and thin, the pair having the appearance of being pressed together laterally, projecting aborally in a prominent rounded keel, and sloping off somewhat ploughshare-like towards the mouth. Two spinelets similar to the general adambulacral armature, only perhaps rather shorter, stand on the superficies of each plate, one on the sloping curve leading to the adoral margin, and the other aboral to this and more outward in relation to the median suture-line of the plates. These spinelets appear greatly modified both in character and position as compared with the usual robust secondary spinelets of the genus. The mouth-spines are represented by two spinelets, similar in all respects to the spines of the adambulacral armature, only rather shorter, placed on the horizontal margin of each plate, and close up to the junction with the first adambulacral plate.

The actino-lateral spines are very long, the longest being about the fifteenth from the mouth. On the inner part of the ray they are comparatively delicate when regard is had to the size of the specimen, increasing, however, in robustness as they proceed along the ray, those near the angle and the succeeding ones being strong and thick. The spines reach quite up to the median line of the interradial area; indeed in the outer half they pass beyond and overlap, whilst the longest spines which fall in the interbrachial arc are much longer than the distance between the median interradial line and the margin of the furrow. In consequence a prominent outward peak is produced in the place of the angle, the web being much contorted, and an abnormal growth not unfrequently takes place, which produces an unsightly excrescence, as well as an irregular thickening of the tissue.

The outer extremities of the actino-lateral spines are not pointed, but rounded; and the web tissue is scarcely indented. Owing to the abnormal growth both of spines and tissues in the interbrachial arc, and the tension produced thereby, the majority of the spines at the extremity of the ray are made to radiate inward towards the angle, and the web appears considerably stretched.

Colour in alcohol, yellowish grey.

Locality.—Station 325. Off the coast of South America, east of Buenos Ayres. March 2, 1876. Lat. 36° 44′ 0″ S., long. 46° 16′ 0″ W. Depth 2650 fathoms. Blue mud. Bottom temperature 32°·7 Fahr.; surface temperature 70°·8 Fahr.

Remarks.—This species is characterised by the peculiar parchment-like appearance of the supradorsal membrane; and may be recognised by the presence of only a single spine in the adambulacral armature and by having very small spiracula, which are arranged in groups and irregularly distributed.

4. *Hymenaster sacculatus*, Sladen (Pl. LXXXV. figs. 1–3; Pl. LXXXVI. figs. 7–9).

Hymenaster sacculatus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 217.

Marginal contour stellato-pentagonoid; interbrachial indentations small; rays usually recurved abactinally, making the abactinal area deeply concave, the actinal being convex. Minor radial proportion 66·6 per cent. R = 42 mm.; r = 28 mm. Rays tapering somewhat sharply at the extremities; marginal fringe distinct and well developed.

The supradorsal membrane is thick and coriaceous in appearance. The papillæ are numerous, and have crowns with rarely more than four or five spinelets, which are prominently protrusive of the membrane—that portion lying between the tips of each individual crown being thick, devoid of spiracula, and forming a slightly distended saccular area. Thick bands of tissue, with fibres, radiate between the crowns, and the narrow interspaces are occupied by numerous small spiracula, generally three or four, or even more, in line together, separated only by very fine, thin dissepiments. The oscular orifice is large; the valves, five in number, are regular, and form when closed a compact exactly fitted pyramid, which rises as a small cone in the centre of the concave abactinal area. The spinelets of the valves are of moderate length, thickly webbed, and with numerous spiracula in the interspaces.

The ambulacral furrows are moderately wide and very uniform in breadth, except towards the extremity, where they taper rapidly, and near the mouth, where they are also somewhat constricted. The armature of the adambulacral plates consists of two spines of moderate length, but with a very long sacculate investing membrane, the pairs standing slightly oblique to the median line of the ray. The aperture-papillæ are large, thickly invested, subspatulate, and slightly constricted near the outer third.

The mouth-plates are elongate, largely keeled, prominent aborally, and each plate

bears two short, thick, dumpy, secondary or superficial spines. One near the adoral extremity, and the other, of similar size and character, standing behind it, about midway on the surface of the plate. There are four small, short, conical mouth-spines on the lateral margin of the plate, ranged serially above and behind the anterior pair of spines just mentioned, and interlocking with the corresponding spines of the neighbouring mouth-angle.

The actino-lateral spines are numerous and very closely placed, the longest spine being far out upon the ray,—a much greater number being included within the interbrachial arc than usual. About forty spines stand on each side of the ray, the twentieth or twenty-first from the mouth being the longest. The spines within the disk are comparatively short and uniform in length, and do not quite meet in the median interradial line; muscular fibre, however, may frequently be seen underlying the outer tissue, passing from the tips of the actino-lateral spines to the corresponding ones of the neighbouring ray. In the immediate arm-angle, however, the spines are longer than the space between the angle and the furrow; so that a considerable overlap takes place, and a consequent puckering and deformity of the tissue ensues, which appears to develop frequently into an unsightly excrescence. The spinelets succeeding to the long ones decrease very rapidly in size towards the extremity of the ray.

Colour in alcohol, brownish white or grey.

Locality.—Station 158. South of Australia, 1099 miles south-west of Cape Otway. March 7, 1874. Lat. 50° 1′ 0″ S., long. 123° 4′ 0″ E. Depth 1800 fathoms. Globigerina ooze. Bottom temperature 33°·5 Fahr.; surface temperature 45°·0 Fahr.

Remarks.—This species may be distinguished from *Hymenaster cælatus*, which it resembles in some respects, by the two large sacculated spines in the adambulacral armature; and by the fact that the spiracula are confined to the interspaces between the raised areas of the paxillæ-crowns, and are not distributed over the area of the crown as well, as in *Hymenaster cælatus*. The colouration, the form of the aperture-papillæ, and the form of the mouth-plates are also different.

5. *Hymenaster echinulatus*, Sladen (Pl. LXXXII. figs. 1 and 2; Pl. LXXXIII. figs. 7–9).

· *Hymenaster echinulatus*, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 218.

Marginal contour pentagonoid. Interbrachial arcs moderately indented, the minor radius being in the proportion of 72·7 per cent. R = 22 mm.; r = 16 mm. The rays are sharply tapered at the extremity, although when seen from above the angles of the pentagon have the appearance of being well rounded, in consequence of the outspreading and graceful curve of the marginal fringe; this is nipped together laterally at the extreme tip, and a slight upward continuation of the furrow is produced thereby. Form depressed, abactinal area slightly conoid, interradial spaces considerably sunken.

The supradorsal membrane is thick and opaque, with very robust broad muscular

fibrous bands, closely but irregularly reticulated, the interspaces being small, usually oval, and each occupied by a single spiraculum. The paxillæ are rather widely spaced, the tips of the spinelets forming prominent little conical peaks or elevations of the membrane, which on certain parts of the area conform themselves to a regular definite order of arrangement. A regular curved row or ridge of these spinelets stands on each side of the median line of the ray, forming a petaloid elevated area, which corresponds with the position of the underlying ray, and imparts a very characteristic facies to the species. A prominent circle surrounds the oscular orifice, marking out in a subpentagonal outline the place of the attachment of the valve-spines. The oscular valves are five in number, composed of rather short radiating spines, forming regular triangular fans, the web which unites them being reticulated in a similar manner to the rest of the supradorsal membrane, the valves when closed forming a prominent pyramidal peak in the centre of the disk. The reticulated supradorsal membrane reaches close up to the margin of the lateral fringe.

The ambulacral furrows are distinctly petaloid. The armature of the adambulacral plates consists of two rather short spines placed side by side well up in the furrow, and forming a straight line parallel thereto. The spines of a pair radiate slightly apart from one another in the plane of their position, and each is covered with a thick semi-transparent membrane which is somewhat expanded opposite the outer third of the spine, imparting thereby an elongate subspatulate form, the adoral spine of a pair having a more robust appearance than its companion. The aperture-papillæ are small and short, suboval in form on the inner portion of the ray, but becoming more elongate as they recede from the mouth.

The mouth-plates are small, with a strongly developed ridge at the line of junction, and a prominent peak aborally. Each plate bears two short, robust, conical secondary surface-spines, one placed near the adoral extremity, and the other about midway along the ridge; both spines are nearly equal in length, not longer than the spines of the adambulacral armature, very wide at the base, and tapering to a blunt extremity, faintly bowed outward and the tip approximated to the tip of the corresponding spine on the companion plate. There are three small mouth-spines; two situated at the extreme outer portion of the lateral margin, and one more inward.

The actino-lateral spines are about twenty-four in number on each side, the eighth or ninth from the mouth being longest. The spines anterior to this are included within the disk, their extremities reaching almost but not quite up to the median interradial line. The succeeding spines diminish in length gradually as they proceed outward, and even towards the extremities remain comparatively long in comparison with those of the other members of the genus. The actino-lateral spines are very robust and taper slightly to the tips, which project well beyond the membrane, and give the appearance of a sharply indented margin. The web of the actino-lateral spines, which also forms the actinal floor, is made up of very thickly packed, fine, delicate, crossing fibres.

Colour in alcohol, light-brown above, pure white beneath.

Locality.—Station 286. In the Mid-South Pacific, near the meridian of 135° W., approximately midway between Sydney and Valparaiso. October 16, 1875. Lat. 33° 29′ 0″ S., long. 133° 22′ 0″ W. Depth 2335 fathoms. Red clay. Bottom temperature 34°·8 Fahr.; surface temperature 63°·0 Fahr.

Remarks.—*Hymenaster echinulatus* is remarkable for the large peak-like prominences formed by the paxillæ-spinelets elevating the supradorsal membrane; it is also distinguished by the two large, often unequal spinelets in the adambulacral armature, and by the deeply festooned marginal fringe.

6. *Hymenaster carnosus*, Sladen (Pl. LXXXVIII. figs. 1–5).

Hymenaster carnosus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 220.

Marginal contour substellate; interbrachial arcs well defined, the minor radius in the proportion of 59·2 per cent. R = 103 mm.; $r = 60$ mm. Rays tapering regularly to the extremity. Abactinal area slightly convex, rising somewhat conoid in the centre; rays rather roundly arched. Actinal area flat or convex. A narrow, thick, fleshy, conspicuous fringe surrounds the entire margin.

The supradorsal membrane is thick, fleshy, and opaque. The paxillæ-spinelets are uniformly and closely distributed over the whole area, protrude greatly, and are covered with membrane, which gives them the appearance of broad-based, robust, conical thornlets, about 3 or 4 mm. in height, springing from the general surface. They are very uniform in size; and no definite order of arrangement is perceptible, nor is it possible to distinguish the individual crowns to which the spinelets belong. A more or less homogeneous muscular layer overspreads the whole area; and no specialised bands or fibres are superficially apparent. The spiracula are quite microscopic, and confined to small round groups, containing two or more very closely crowded together, placed in the hollow interspaces between the spinelets, and the whole quite invisible to the naked eye. The oscular orifice, which is large, has broad valves, squarely truncate at the extremity and all webbed together, the prominent thorn-like spinelets above mentioned marking out a circle at their bases of attachment 24 mm. in diameter.

The ambulacral furrows are wide (8·5 mm.), nearly uniform in breadth until near the extremity, where they gradually contract. The tube-feet are numerous and closely crowded, but maintain the regular biserial arrangement. The armature of the adambulacral plates consists of two long, needle-shaped spinelets, placed side by side, in line with the margin of the furrow, or the very slightest trace oblique. The adoral spinelet is somewhat the longer, and both are invested with an extensive saccular membrane extending beyond the extremity, often to a length equal to that of the spinelet itself. The aperture-papillæ are moderately large, elongate, and suboval. A fleshy thickening

or pad is developed on the surface that fits over the aperture, upon which it closes like a valve.

The mouth-plates are of moderate size; widely expanded laterally, the keel along the junction being well developed, prominent aborally, and with a rather produced peak adorally. Two secondary or superficial spines are present on each plate—one near the adoral extremity, the other shorter and more robust, midway on the plate and with a wide-flaring investment. It is a question whether the anterior pair ought not, from their position, to be ranked with the true mouth-spines. Mouth-spines proper three or four in number, acicular, and placed on the margin of the lateral flange.

The actino-lateral spines are closely placed, and entirely hidden in the thick fleshy membrane with which the actinal interradial areas are uniformly covered; fifty to sixty spinelets are present on each side of the ray.

Colour in alcohol, purplish grey on the abactinal surface, pinkish purple on the actinal surface.

Locality.—Station 295. Off the west coast of South America. November 5, 1875. Lat. 38° 7′ 0″ S., long. 94° 4′ 0″ W. Depth 1500 fathoms. Globigerina ooze. Bottom temperature 35°·3 Fahr.; surface temperature 58°·5 Fahr.

Remarks.—This is a large form, approaching *Hymenaster nobilis* in size, which it also resembles in its fleshy habit. In *Hymenaster carnosus*, however, the paxillæ-crowns do not form definite areas, and the spinelets are large and spike-like; the spiracula are very minute and arranged in groups; and there are two spinelets in the adambulacral armature.

7. *Hymenaster glaucus*, Sladen (Pl. LXXXIV. figs. 1 and 2; Pl. LXXXVI. figs. 4–6).

Hymenaster glaucus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 221.

Marginal contour stellato-pentagonal. Interbrachial arcs well indented, forming a distinct angle, except in very large specimens, where the web has become somewhat overgrown, and abnormally thickened. Minor radial proportion from 68 to 76 per cent. $R = 46$ mm.; $r = 35$ mm. The rays taper to a fine extremity and the web is rather full on the margins, and somewhat irregular in consequence. General form very depressed. On the abactinal surface the radial areas are well marked out, distinct from the fringe and interradial membrane, by a regular linear arrangement of paxillæ-spinelets, the radial areas being elevated above the general surface. The pseudo-sides of the rays are short and perpendicular; the rays themselves having the appearance of standing in relief above the superficies of the marginal and interradial webs, tapering to a fine point, and maintaining their distinctness up to the very extremity. The lateral web or fringe is largely developed, and, being rather full, is in consequence somewhat irregular.

The supradorsal membrane is furnished with very numerous muscular fibres, which

radiate from the tips of the spinelets and pass to those standing in close proximity around, the bands crossing at various angles, overlying and underlying one another, and forming an interlacing tissue rather than a truly reticulated structure. The spiracula, which are moderately large, are irregularly placed and not numerous. The paxillæ seldom have more than three spinelets, which are usually aggregated close together and especially so along the median line of the ray and at the extremity, forming a crown of small expansion. Towards the disk the spinelets are more widely spaced; and the paxillæ, which form the pseudo-sides of the ray, are disposed in a perfectly straight line, no stragglers encroaching on the web or interradial area.

The oscular aperture is large and conspicuous; the valves are regular and formed of comparatively few spinelets, seldom more than a dozen in each. The outer margin of the oscular ring is very strikingly marked out by short, prominently protruding, pointed spinelets, excentrically directed, very regularly disposed, and from the tips of which the membrane hangs in graceful folds.

The ambulacral furrows are moderately broad, sublanceolate in outline, fairly uniform in width except near the mouth where they are constricted, and along the outer fifth where they taper rapidly up to the extremity. The armature of the adambulacral plates consists of two short, acicular, pointed spinelets, covered with membrane which forms a moderately developed terminal sacculus. In some specimens this appears to be much more developed in the adoral spine of the pair than in the aboral, which seems frequently to be smaller than the other. The aboral spine is also placed higher in the furrow than the adoral. The aperture-papillæ are large, and with their investment, broadly lanceolate or acumino-spatulate in form.

The mouth-plates are short and rather broad, the aboral prominence being blunt and well rounded. Each plate bears two very short, robust, stumpy secondary or superficial spines, the adoral one (which is placed forward on the plate) being shorter even than the mouth-spines proper, but much more robust. The mouth-spines proper, which are four or five in number on each plate, are rather long, fine, and nearly equal in length.

The actino-lateral spines are robust and well-spaced, the fourteenth or fifteenth from the mouth being longest. None meet in the interradial median line, not even the longest, the space being filled in with fleshy membrane.

Colour in alcohol, dirty white in large specimens, greenish grey in those of smaller size.

Locality.—Station 235. Off Japan, south of Omae saki. June 4, 1875. Lat. 34° 7′ 0″ N., long. 138° 0′ 0″ E. Depth 565 fathoms. Green mud. Bottom temperature 38°·1 Fahr.; surface temperature 73°·0 Fahr.

Remarks.—*Hymenaster glaucus* may be readily distinguished by the conspicuously defined radial areas raised in relief above the rest of the abactinal surface, by the paxillæ with three spinelets, and by the character of the supradorsal membrane.

8. *Hymenaster vicarius*, Sladen (Pl. LXXXIV. figs. 3 and 4; Pl. LXXXVI. figs. 1–3).

Hymenaster vicarius, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 223.

Marginal contour subpentagonal. Interbrachial arcs well indented, the minor radius being in the proportion of 69·2 per cent. R = 39 mm.; $r = 27$ mm. The lateral fringe is more or less distinct, and its margin forms a line that curves outwards after passing the middle of the ray, adding greatly to the appearance of its breadth; the margin then suddenly contracts and emphasises the rapid tapering of the ray at the extremity.

The supradorsal membrane is thin and papyraceous in appearance. The muscular fibres are numerous and irregular, rather thick, closely placed, and radiate from the tips of each spinelet to those around, thus forming an interlacing web with moderately large meshes of rhomboid or quadrate form. The interspaces are filled in with transparent membrane, punctured in the centre by a spiraculum; these are moderately large, well spaced, and uniformly, though irregularly, distributed over the abactinal area. The paxillæ are numerous, and composed of four, five, or six spinelets, rather short and pointed, their tips elevating the membrane into small pointed papillæ, which are very evenly spaced over the abactinal area and appear to rise sharply from the surface, whilst their small size and comparative closeness of position give an easily recognisable character to the starfish.

The ambulacral furrows are moderately broad, lanceolate in outline, and taper rather rapidly before they reach the extremity, which is in consequence somewhat produced. The armature of the adambulacral plates consists of two rather short, cylindrical, and pointed spines, covered with an extensive investing membrane which forms an elongate sacculus at the tip, and also adds greatly to the apparent robustness of the spinelets. The aperture-papillæ are large, acumino-spatulate, wide and rotund at the base, and often contract rapidly to a point at the free extremity, or may be simply rounded.

The mouth-plates are small, elongate, narrow, keeled, and prominent aborally. Each bears two short robust secondary surface-spines, one near the adoral extremity, and the other placed more aborally near the middle of the plate. The horizontal margins of the plate falling into the actinostome are expanded into a rather wide flange, upon the edge of which are situated four or five short cylindrical mouth-spines, slightly curved and rounded at the tips, but not tapering.

The actino-lateral spines are delicate, those included within the disk being short and not reaching up to the median interradial line, but leaving a rather wide space. The longest spine is about the fifteenth from the mouth, but even these do not meet in the interbrachial arc, where a considerable amount of thickening and deformity of the membrane occurs. The tips of the spinelets are rather tapering, and not thickened or knobbed. The margin of the web is slightly thickened, not indented or festooned.

Colour in alcohol, white, tinged with yellow, where the membrane is thickened in the interbrachial arcs. The tube-feet are yellow.

Locality.—Station 300. Off the coast of South America, between the Island of Juan Fernandez and Valparaiso. December 17, 1875. Lat. 33° 42′ 0″ S., long. 78° 18′ 0″ W. Depth 1375 fathoms. Globigerina ooze. Bottom temperature 35°·5 Fahr. ; surface temperature 62°·5 Fahr.

Remarks.—*Hymenaster vicarius* has a somewhat parchment-like supradorsal membrane, the delicate spinelets of the paxillæ elevating it into small pointed peaks, the spinelets being often very prominent ; this appearance is emphasised by the delicacy of the membrane, which allows a considerable portion of the spine to be visible. This pseudospinous character and the broad lanceolate rays serve to distinguish the species from its congeners.

9. *Hymenaster pellucidus*, Wyville Thomson (Pl. LXXX. figs. 1–5).

Hymenaster pellucidus, Wyville Thomson, 1873, The Depths of the Sea, p. 120, fig. 16.

Locality.—" Porcupine " Expedition :

Station 59, 1869. In the Faeröe Channel. Lat. 60° 21′ N., long. 5° 41′ W. Depth 580 fathoms. Bottom temperature −1°·3 C. ; surface temperature 11°·5 C.

Remarks.—This species has been so fully and carefully described by Drs. Danielssen and Koren[1] that it would be superfluous to redescribe the single example which is at my disposal. As, however, this is the type specimen—and of some importance historically—I have given drawings of it, which will probably not be without interest.

Hymenaster pellucidus was dredged during the Norwegian North Atlantic Expedition at a number of stations off the Coast of Norway, off the Island of Jan Mayen, off Spitzbergen, and in the intermediate seas, the most northerly station being in lat. 80° 3′ N., the depths ranging from 70 to 1539 fathoms.

10. *Hymenaster infernalis*, Sladen (Pl. LXXXVII. figs. 4–7).

Hymenaster infernalis, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 224.

Marginal contour substellate ; interbrachial arcs well indented and somewhat angular, the minor radius being in the proportion of 43 per cent. R = 28 mm. ; $r = 12$ mm., approximately. Rays broad at the base, but greatly attenuated outwardly. General form depressed.

The supradorsal membrane is very thin. The paxillæ have long pedicles surmounted by eight to ten elongate delicate spinelets. The muscular fibres, which are extremely fine and thread-like, are rather numerous, and radiate from the tips of the spinelets, which

[1] Den Norske Nordhavs-Expedition, 1876–1878, Zoologi, xi. Asteroidea, 1884, p. 72, pl. xiii. figs. 1–17, pl. xv. figs. 7 and 8.

are more or less prominent, suggesting the character of the same structure in *Hymenaster pullatus*, the fibres, however, being much more delicate and less numerous. The spinelets which form the valves of the oscular orifice are rather robust.

The ambulacral furrows are narrow. The armature of the adambulacral plates consists of two long and needle-shaped spines, placed slightly oblique to the line of the furrow. The innermost aperture-papilla is very large and comb-formed, composed of radiating shafts. The adambulacral plates are elongate.

The mouth-plates have a prominent and rather angular keel along the line of juncture, and bear two short and moderately robust superficial or secondary mouth-spines, the anterior pair close to the adoral margin. Several (three or more) mouth-spines are present on the margin of the lateral expansions.

The actino-lateral spines are short, robust, and placed wide apart, the sixth or seventh from the mouth being longest; the character along the free portion of the ray is indeterminable. The actinal membrane is furnished with numerous fine muscular fibres.

Locality.—Station 244. In the Mid-North Pacific, between Yeddo and San Francisco, near the meridian of 170° E. June 28, 1875. Lat. 35° 22′ 0″ N., long. 169° 53′ 0″ E. Depth 2900 fathoms. Red clay. Bottom temperature 35°·3 Fahr.; surface temperature 70°·5 Fahr.

Remarks.—Unfortunately this delicate specimen has been so shattered and distorted that its present state of preservation will not admit of a satisfactory description. This difficulty of study is the more to be regretted as the form is one of the deepest dwelling Asterids obtained during the Expedition. The characters above enumerated are sufficient, however, to indicate that the species under notice is clearly distinct from any other in the group. The attenuation of the rays, the number and delicacy of the paxillæ-spinelets, and the characters of the actinal surface readily distinguish the form. On these grounds I have considered it advisable to establish the species, although loth to do so on such imperfect material.

11. *Hymenaster cælatus*, Sladen (Pl. LXXXV. figs. 4 and 5; Pl. LXXXVI. figs. 10–12).

Hymenaster cælatus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 225.

Marginal contour stellato-pentagonoid. Interbrachial arcs sharply indented, the minor radius being in the proportion of 63·3 per cent. R = 30 mm.; r = 19 mm. The abactinal area is concave, the rays being curved upward and their extremities recurved and quite turned over. Actinal area very convex. The radial areas are well marked out, the lateral margins converging gradually to the tip, which is not attenuated or produced. A secondary membrane extending beyond the actino-lateral spines forms a conspicuous fleshy fringe.

The supradorsal membrane is rather thick. The paxillæ are composed of four or five

spinelets, forming regular crowns, which elevate the membrane into rhomboid or pentagonal areas, apparently raised in relief, and closely placed, the margins of the raised areas being more or less incurved, and the intervening spaces deep and furrow-like. The muscular fibres are closely interwoven, the bands ill-defined, and the meshes irregular; the spiracula are small, and frequently two or more together, this structure being uniform over elevated areas and interspaces alike. The tips of the paxillæ-spinelets are only slightly protuberant; the relief-areas which fall in the margin of the ray are smaller, more compressed, and somewhat modified in form as compared with the others. About seven longitudinal rows of elevated areas or paxillæ-crowns may be counted at the base of a ray.

The oscular orifice is small, the circumference at the base of the valves pentagonal, 9·25 mm. in diameter, and marked out by spinelets. There are five valves, which are very regularly triangular, with their apices sharply pointed, and all webbed together, the whole forming a regular pyramid when closed. The innermost two spines of each valve stand somewhat apart, and the membrane is rather deeply drawn in between, producing a well-defined furrow along the median line. The projecting tips of spinelets are prominent at the sides of the valves. At the base of each valve are two large elevated areas, formed by paxillæ-crowns of six to eight spinelets, and thus nearly twice the size of the other crowns upon the abactinal surface; they are subpentagonal in shape, and the ten form a conspicuous and well-defined circlet round the oscular pyramid.

The ambulacral furrows are rather wide, straight, uniform in breadth, except at the extremity, where they rapidly converge. The armature of the adambulacral plates consists of three very short, cylindrical, slightly tapering spines, covered with membrane, and placed in line oblique to the furrow.

The aperture-papillæ are large and subcircular, with their investing membrane somewhat Japanese fan-shaped. The calcareous portion of the papillæ is very flaring in habit, sometimes appearing as if made up of a comb of radiating spinelets.

The mouth-plates are small, short, but broad, and with widely expanded lateral flanges, broadly rounded in front; the keel along the line of junction is feebly developed, the aboral extremity being only slightly prominent. Two secondary or superficial spines are borne on slight tubercles, one near the adoral extremity and the other near the middle of the plate. These spines are short, comparatively small, broad at the base, and taper slightly at the tip,—the adoral pair being rather the smaller and not much larger than the spines on the adambulacral plates. There are three mouth-spines, which are similar in size and form to the adambulacral spines, arranged on the lateral margin of the plate and away from the adoral peak of the keel.

The actino-lateral spines are widely spaced, the difference in the length being comparatively small along the inner two-thirds of the ray. About twenty-seven spines are present on each side of a ray, the sixth or seventh from the mouth being slightly longest. None of the spines meet in the median interradial line, but are widely separate; they

are covered with a thick fleshy tissue, which is slightly turned over the tips of those spinelets that fall beyond the summit of the interbrachial arc, and extends up to within a short distance of the extremity of the ray, gradually diminishing in breadth as it proceeds outwards. The margin of this supplementary fringe is thickened, and furnished with a powerful muscular band.

Colour in alcohol, a rather livid pink, the ambulacral furrows and tube-feet being a yellowish white.

Locality.—Station 158. South of Australia, 1099 miles south-west of Cape Otway. March 7, 1874. Lat. 50° 1′ 0″ S., long. 123° 4′ 0″ E. Depth 1800 fathoms. Globigerina ooze. Bottom temperature 33°·5 Fahr.; surface temperature 45°·0 Fahr.

Remarks.—This exceedingly handsome species is characterised by the definitely raised areas of the paxillæ-crowns. A similar structure occurs in *Hymenaster sacculatus*, but is not so strikingly developed. The two species may be readily distinguished by the structure of the supradorsal membrane, by the disposition of the spiracula, by the armature of the adambulacral plates, and by the general form. The colour also is different.

12. *Hymenaster crucifer*, Sladen (Pl. LXXXIX. figs. 1 and 2; Pl. XCI. figs. 1–3).

Hymenaster crucifer, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 227.

Marginal contour subpentagonal. Interbrachial arcs very slightly indented, the minor radius being in the proportion of 66·6 per cent. R = 51 mm.; $r = 34$ mm. Rays tapering to a fine extremity, which is somewhat attenuated and produced. Marginal fringe comparatively insignificant as seen from above, and narrowing rapidly towards the extremity of the rays. Form depressed, more convex on the actinal than on the abactinal surface.

The supradorsal membrane is rather thin; the muscular fibres are numerous, thick, and radiate regularly from the tips of the spinelets. The paxillæ are numerous, though somewhat widely spaced, and bear a crown of four or sometimes five spinelets, which usually elevate the membrane into slightly raised Maltese cross-shaped areas. The spinelets are sharply prominent, and the fibres for a short distance round the tip are merged together and form a homogeneous "cap;" the caps of each of the spinelets of a crown coalesce, and thus produce the subcruciform or rhomboid elevation above mentioned. The paxillæ are well spaced, and are arranged in longitudinal lines along the rays. No spiracula occur on the raised areas, but in the intermediate spaces they are very numerous and closely placed, the intervals between the thick radiating bands being very narrow, and occupied by a great number of small spiracula placed close together in lines, four to eight or even more in each, and separated from one another by only the finest dissepiment. The numerous spiracula and the isolated unpunctured cruciform areas give a striking character to the abactinal surface. The oscular orifice is large, the valves all webbed together, and the spinelets quite hidden in membrane, the whole of which is uniformly punctured with a

great number of small spiracula not quite so closely placed as those on the disk, and not arranged in lines.

The ambulacral furrows are rather widely petaloid, and rapidly constricted at the extremity. The armature of the adambulacral plates consists of three short spines, nearly uniform in length, pointed, and covered with a membrane expanded into a lanceolate shape, but with no terminal saccular prolongation. Each series of spines is placed diagonally upon its plate, or oblique to the line of the furrow. The aperture-papillæ are large and broadly subspatulate or even subrhomboid, expanded somewhat obliquely, the pedicle seeming to be attached rather on one side. The mouth-plates are rather broad, prominent aborally, and have five or six short mouth-spines attached to the lateral aliform extensions, and directed horizontally. Two short, robust, subconical secondary mouth-spines are borne on the superficies of each plate—one near the adoral extremity, and the other, which is thickest, placed midway between this spine and the aboral extremity of the mouth-plate.

The actino-lateral spines are long and well spaced, about forty on each side of a furrow, the eleventh or twelfth from the mouth being longest. The spines within the disk do not quite meet in the median interradial line, and those along the outer third of the ray diminish in length very rapidly; they are, however, rather irregular in their length throughout, which gives a ragged appearance to the fringe. The spines are pointed at their extremities, and the web is very slightly indented between.

Colour in alcohol, yellowish grey.

Locality.—Station 158. South of Australia, 1099 miles south-west of Cape Otway. March 7, 1874. Lat. 50° 1′ 0″ S., long. 123° 4′ 0″ E. Depth 1800 fathoms. Globigerina ooze. Bottom temperature 33°·5 Fahr.; surface temperature 45°·0 Fahr.

Remarks.—Hymenaster crucifer is distinguished, as its name implies, by the peculiar cross-like markings formed by the paxillæ-crowns. A further characteristic feature is furnished by the general structure of the supradorsal membrane and the lineal disposition of the spiracula.

13. *Hymenaster anomalus*, Sladen (Pl. LXXXIX. figs. 3 and 4; Pl. XCI. figs. 4–6).

Hymenaster anomalus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 228.

Marginal contour stellato-pentagonal. Interbrachial arcs wide and rather sharply and angularly indented, the minor radius being in the proportion of 63 to 65 per cent. R = 15 mm.; $r = 9{\cdot}5$ mm., approximately. Rays subtriangular in outline, and tapering to a fine extremity. Form very depressed, only slightly elevated in the centre of the disk. Marginal fringe quite inconspicuous when seen from above.

The supradorsal membrane is furnished with uniformly thick fibrous bands, closely reticulated, the network exhibiting a certain incipient regularity of construction. The

meshes or interspaces are large and equidistant, and a more or less distinct grouping round centres is distinguishable, where the fibres become massed together—these thickened portions corresponding usually with the tips of the spinelets, upon which they form a cap. Six to eight bands usually radiate from these centres; and if the plan just indicated were regularly carried out, an arrangement of more or less distinctly hexagonal compound meshes, divided by fibres radiating from their centre, would be produced—one primary mesh around each spinelet, and secondary meshes within this formed by each of the radiating fibres. This disposition of reticulation, however, is by no means regular, as numerous supplementary meshes and centres occur. The meshes are usually circular, oval, or subtriangular in outline, and are filled in with a fine semitransparent membrane punctured in the centre with a minute spiraculum, which is surrounded by an opaque whitish ring. The supradorsal membrane and its system of reticulated fibres extends almost up to the extreme edge of the lateral fringe. The tips of the paxillæ-spines produce slight, uniform, rounded elevations of the membrane, distributed over the whole abactinal area, to which they give a papillose or coarsely granulated appearance when seen by the naked eye. The oscular orifice is small, the circumference at the base of the valves being circular and well marked out. The spines of the valves are webbed together by an investing membrane, with reticulated fibres, into five regular, triangular fans, the margins overlapping and, when shut down, completely closing the oscular orifice.

The ambulacral furrows are lanceolate, scarcely, if at all, expanded in the middle, and gradually tapering to the extremity. The armature of the adambulacral plates consists of three short spinelets, placed obliquely—the two outermost standing at almost right angles to the furrow, the innermost, which is slightly smaller, being placed rather in advance of, or aboral to, these latter. The spines are invested with an extensive transparent membrane, and frequently two, or even all the three, are webbed together. When single, the covering gives them a broadly lanceolate shape. The aperture-papillæ are very small and elongately oval in form.

The mouth-plates are small, the pair forming a prominent though narrow ridge. Each plate carries three very robust, blunt, secondary superficial spinelets placed in line along each side of the keel, the anterior pair near the adoral extremity, and the posterior pair near the aboral extremity of the mouth-plate. They differ slightly in size, the adoral being smallest and the aboral largest. On the horizontal margin of each plate are two mouth-spines, the innermost pair immediately above the anterior secondary spinelets, of which series they seem to form a continuation, being directed downward and centripetally. The aboral pair of secondary spinelets are directed centrifugally. The second or outer mouth-spine is very much smaller and placed away from the inner mouth-spine, somewhat isolated on the margin of the plate, and is directed horizontally.

The actino-lateral spines are about twenty-one on each side (of fairly large ones only eighteen), the sixth from the mouth being longest; this and all the spines preceding it

join close up in the median interradial line with the corresponding spine of the neighbouring ray, whilst the succeeding spines diminish by regular steps. The spines are tapering and pointed. The membrane is made up of very fine fibres. The margin is very slightly festooned between the tips of the spines.

Colour in alcohol, white; the ambulacral furrows and the tube-feet being yellowish brown.

Locality.—Station 335. North of the Island of Tristan da Cunha. March 16, 1876. Lat. 32° 24′ 0″ S., long. 13° 5′ 0″ W. Depth 1425 fathoms. Pteropod ooze. Bottom temperature 37°·0 Fahr.; surface temperature 73°·5 Fahr.

Remarks.—This species differs from all other members of the genus by the remarkable character of the armature of the adambulacral plates and of the mouth-plates. The superficial appearance of the abactinal area is also exceedingly ornate and characteristic.

14. *Hymenaster latebrosus*, Sladen (Pl. XCII. figs. 4 and 5; Pl. XCIII. figs. 7–9).

Hymenaster latebrosus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 230.

Marginal contour substellate. Interbrachial arcs sharply indented, the minor radius being in the proportion of 63·6 per cent. $R = 22$ mm.; $r = 14$ mm. Interbrachial arcs acute. Rays broad and subtriangular, with their margins gracefully curved outward. General form depressed; abactinal surface over the rays more or less bombous; radial areas not specially defined. Supradorsal membrane continuous up to the margin; lateral fringe narrow, regular, and sharply indented.

The supradorsal membrane is fine and semitransparent. The paxillæ-spinelets are uniformly distributed over the entire area, but present no definite order of arrangement. The paxillæ are composed of few spinelets, four or five being the general number. The muscular fibres are numerous and closely, though rather coarsely and irregularly, reticulated (intercrossed). The interspaces are filled in with a delicate semitransparent membrane, punctured with spiracula, usually one to a mesh, and consequently rather widely spaced. The oscular orifice is comparatively small, the valves lying almost level with the surface of the supradorsal membrane.

The ambulacral furrows are moderately broad, and subpetaloid in outline, tapering gradually to the extremity along the outer third of the ray, and slightly constricted towards the actinostome. The armature of the adambulacral plates consists of three short, cylindrical spines rapidly tapering to a fine point, and covered with thin membrane. Each series is placed high in the furrow, and very oblique to the median line of the ray; the aboral spinelet is much smaller than the other two, of which the adoral is slightly the longest. The aperture-papillæ are small and oval or subcircular in form, and are sometimes expanded laterally to such an extent that the breadth is greater than the length.

The mouth-plates are comparatively small and short; the keel is prominent, having a

rhomboid outline when seen from above, and inclined upward into the mouth cavity, with rather widely expanded lateral flanges, which are straight and square in front. Each plate bears two robust secondary spines, one on the middle of its surface, standing in the lateral angle of the rhomb, and another comparatively smaller and thinner placed nearer the adoral extremity. The mouth-spines proper are represented by three small tapering spinelets placed on the lateral margin of each plate.

The actino-lateral spines are robust and of moderate length, the seventh to the ninth from the mouth being longest. The spines of two adjacent rays do not quite meet in the median interradial line, a little narrow channel or wrinkle of the membrane being maintained between their tips. The spines diminish regularly in length after the angle is passed until they become microscopic at the end of the ray; they are pointed at their outward extremities, and the web being well indented between gives a serrate appearance to the margin.

Locality.—Station 157. In the Southern Ocean, near the meridian of 110° E. March 3, 1874. Lat. 53° 55′ 0″ S., long. 108° 35′ 0″ E. Depth 1950 fathoms. Diatom ooze. Bottom temperature 32°·1 Fahr.; surface temperature 37°·2 Fahr.

Remarks.—*Hymenaster latebrosus* may be distinguished by its general form, by the structure of the supradorsal membrane, and by the armature of the adambulacral plates. I know of no species for which it could be mistaken.

15. *Hymenaster porosissimus*, Sladen (Pl. LXXXII. figs. 3 and 4; Pl. LXXXIII. figs. 10–12).

Hymenaster porosissimus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 231.

Marginal contour subpentagonal. Interbrachial arcs scarcely indented, forming simply a slight curve inward. The minor radius is in the proportion of 75·5 per cent. R = 45 mm.; r = 34 mm. The rays do not taper beyond the extent of a true pentagon, and are slightly rounded at the extremity, which is somewhat feebly upturned.

The supradorsal membrane is very uniformly reticulated; the muscular fibres are so closely and regularly placed that their radiation from the spinelet-tips as centres is scarcely apparent; the meshes are very small and regularly placed, each with one small spiraculum.

The paxillæ-spinelets, which are three, four, or five in number, and evenly spaced, are rounded at the tips, very slightly prominent, and produce a uniformly papillate appearance on the abactinal area, no general pattern of arrangement being discernible. The crowns of a great number of the paxillæ form a more or less distinctly visible Maltese cross, in consequence of two prominent fibres joining the tips of the opposite spinelets. The oscular orifice is moderately large; the circumference at the base of the valves being very clearly marked out by prominent spinelets. The valves are triangular, five in number, and form

a regular pyramid; the whole series are webbed together with a membrane closely punctured with spiracula like the rest of the supradorsal membrane, and there are two or three prominent spinelets projecting along the sides of each valve.

The ambulacral furrows are rather wide, subpetaloid, or gracefully lanceolate. The armature of the adambulacral plates consists of three short, delicate, slightly tapering spines, nearly equal in length, and covered thinly with membrane, but with no saccular extension present. Each series is placed slightly oblique to the median line of the ray. The aperture-papillæ are large and squarely oval, with a thick plump sacculus, and are attached close up to the outer extremity of the diagonal series of spinelets on the adambulacral plates.

The mouth-plates are very elongate and remarkably narrow, the pair together forming a prominent, elevated rounded ridge, which is tapering and roundly pointed at each extremity. Near the adoral extremity of each plate stands a single, rather large spine, subconical, and becoming attenuated towards the extremity, but not pointed. These spines are directed horizontally over the peristome, the pair in each mouth-angle diverging slightly apart from one another and away from the median line of the mouth-plates; these are the anterior pair of secondary mouth-spines, placed unusually forward. From the superficies of each mouth-plate, and about one-third from the inner or adoral extremity, rises a second, robust, subconical, and moderately long spinelet, directed downward and slightly inward. Both these pairs of secondary or superficial spinelets are about equal in length to the spinelets on the adambulacral plates, but are more robust, the aboral being stouter but rather shorter than the companion pair. The mouth-spines, which are four or five in number, are short, subcylindrical, thickened at their bases, placed on the margin of the plates, and directed horizontally. These spines are much smaller and shorter than the secondary or superficial spines above noted, and are attached to a wide lateral extension or flange of the mouth-plate.

The actino-lateral spines are long and rather widely spaced, the longest being about midway out on the ray (the eleventh from the mouth); about forty in all are present. The spines within the disk come nearly up to the median interradial line, but do not meet. The spines whose free extremities fall in the marginal fringe diminish gradually and with regularity up to the extremity, the last few maintaining, however, a nearly uniform length, which gives a rounded appearance to the fringe at the ray-tips. The actino-lateral spines are finely pointed at their extremities, and the web-membrane is moderately indented between them; the marginal fringe is perfectly even and regular, forming a conspicuous marginal border when seen from the upper surface, although the reticulated supradorsal membrane is continued close up to the margin.

Colour in alcohol, greyish white.

Locality.—Station 300. Off the coast of South America, between the Island of Juan Fernandez and Valparaiso. December 17, 1875. Lat. 33° 42′ 0″ S., long. 78° 18′ 0″ W.

Depth 1375 fathoms. Globigerina ooze. Bottom temperature 35°·5 Fahr.; surface temperature 62°·5 Fahr.

Remarks.—This species may be recognised by the remarkably uniform character of the small rounded elevations on the supradorsal membrane, and by the great number and regular arrangement of the spiracula. The armature of the adambulacral plates and of the mouth-plates also furnish conspicuous features by which the species may be distinguished.

16. *Hymenaster graniferus*, Sladen (Pl. XC. figs. 1 and 2; Pl. XCI. figs. 7–9).

Hymenaster graniferus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 233.

Marginal contour almost pentagonal, the interbrachial arcs being very slightly incurved. The rays are more or less attenuated or produced at the extremity, which is upturned; and their effect on the contour is consequently inconspicuous. Minor radial proportion about 69 to 73 per cent. R = 30 mm.; $r = 22$ mm. The radial areas are not specially defined externally from the rest of the abactinal surface. Lateral fringe or web thickened at the margin and little conspicuous.

The supradorsal membrane is delicate. The paxillæ-spinelets, which are delicate, and have fine sharp extremities protruding well through the supradorsal membrane, are evenly distributed over the area, but present no definite pattern of arrangement. The fibrous bands, which are rather thin but clearly defined, are comparatively few in number, well isolated, and radiate not only to those spinelets which form the immediate circle, but some also pass through the interspaces and reach to the spinelets beyond. In this manner a more or less irregular and very open network is produced, in which, however, a tendency to an interpenetrant hexagonal pattern is discernible as the general plan here and there; and the whole is overlaid by a very delicate semitransparent membrane, in which a number of small, round, closely placed granule-like bodies occur. The spiracula are small and sporadically placed; very frequently two or even three occur together in the mesh, but the groups are well isolated, and the apertures by no means numerous. The oscular orifice is large and closed with five regular valves which fit evenly together, each with about a dozen spines, the innermost two being longest, and the others diminishing regularly and gradually, the articulatory base being prominent.

The ambulacral furrows, which are narrow, are much constricted towards the actinostome and at the extremity of the ray. The armature of the adambulacral plates consists of three acicular spinelets, which are unequal in length and rather short, placed in line parallel to the median line of the furrow, excepting towards the extremity, where the series becomes rather oblique. The aboral spine is almost abortive, and the middle one less than the adoral spine of the trio; this latter is invested with a widely expanded sacculus, which makes the spine appear many times thicker than its companion

and nearly twice as long, the large sacculus usually taking a pointed or sublanceolate form, whilst the small investment of the abortive aboral spine is generally rounded and somewhat knobbed. The aperture-papillæ are remarkably large and elongately oval, and are, with their membrane, acumino-spatulate in shape, and much broader than the sacculated spinelets on the adambulacral plates, and often nearly as long.

The mouth-plates are short and comparatively broad, with widely expanded lateral flanges. No prominent keel is formed along the line of junction, which is flatly rounded. Two robustly clothed, rather short, obtuse secondary or superficial spines are present on each plate, one near the adoral edge, the other near the middle of the plate, both maintaining a wide space between their corresponding spines on the adjoining plate. About four mouth-spines proper stand on the horizontal margin of each plate, which are moderately long, very wide at the base, and sharply tapering, the external one sometimes being reduplified.

The actino-lateral spines are delicate, well spaced, and the longest is about the fifteenth from the mouth; none meet in the interradial line, but are widely separate even at the summit of the interbrachial arc; the spines vary but little in length up to this point, but diminish very rapidly beyond.

Colour in alcohol, white.

Locality.—Station 146. Between Marion Island and the Crozet Islands. December 29, 1873. Lat. 46° 46′ 0″ S., long. 45° 31′ 0″ E. Depth 1375 fathoms. Globigerina ooze. Bottom temperature 35°·6 Fahr.; surface temperature 43°·0 Fahr.

Remarks.—*Hymenaster graniferus* is a very distinct form, characterised by the presence of granular bodies in the supradorsal membrane, by the simplicity of the muscular fibres in the membrane, by the paucity of the spiracula, and by the armature of the adambulacral plates and mouth-plates.

17. *Hymenaster geometricus*, Sladen (Pl. XCII. figs. 2 and 3; Pl. XCIII. figs. 4–6).

Hymenaster geometricus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 234.

Marginal contour substellate. Interbrachial arcs well rounded, the minor radius being in the proportion of 52·3 per cent. R = 42 mm.; r = 22 mm., approximately. Rays greatly attenuated and tapering, with the fringe almost, if not quite, aborted towards the extremities. Abactinal surface uniformly flat. Actinal surface prominently convex.

The supradorsal membrane is thin and semitransparent, supported by extremely delicate thread-like fibres, which form a regular pattern upon the disk. Usually six fibres proceed from the tip of each paxilla-spinelet, and pass to the tips of the neighbouring spinelets; as these are all equidistant, it follows that a series of regular interpenetrant hexagons is produced. The fibres are all of uniform length, and do not cross over or under one another as in *Hymenaster pullatus*. The spaces marked out or

bounded by the fibres form regular triangular meshes, and enclose several small spiracula, generally three to five in number. Sometimes the fibres are doubled, and the tips of the spinelets protrude prominently.

The valves of the oscular orifice are not conspicuous, the general tissue of the supradorsal area just described being apparently continued up to the extremities of the valves, whilst their bases of attachment, which are usually well marked out by spinelets on prominent bosses, are indistinguishable in the present example.

The ambulacral furrows are rather narrow, and not petaloid. The armature of the adambulacral plates consists of three long and needle-shaped spines placed in line parallel to the median line of the ray, the adoral spine being longer than the breadth of the furrow. The aperture-papillæ are of moderate size and subquadrate, or rather elongate in shape, when invested with membrane.

The mouth-plates are short, with wide lateral flanges; the keel along the line of junction very prominent aborally. There are five or six mouth-spines on each plate, which are moderately long and subacicular, the middle one being longest; the innermost one ought perhaps to be ranked as a secondary or superficial mouth-spine, although similar in form and serial in position to the true mouth-spines. Midway on the superficies of the plate and well away from the median keel is a longer and slightly more robust secondary spinelet, similar in character to the rest of the armature.

The actino-lateral spines are very wide apart, and there are probably not more than twenty on a side, although the rays are so long; the fourth or fifth spine from the mouth is longest; these and the preceding spines, which are included within the disk, all converge towards the interbrachial arc instead of running parallel to one another as in nearly all the species of this genus.

Locality.—Station 286. In the Mid-South Pacific, near the meridian of 135° W., approximately midway between Sydney and Valparaiso. October 16, 1875. Lat. 33° 29′ 0″ S., long. 133° 22′ 0″ W. Depth 2335 fathoms. Red clay. Bottom temperature 34°·8 Fahr.; surface temperature 63°·0 Fahr.

Remarks.—*Hymenaster geometricus* is distinguished by the great attenuation of the rays, and by the remarkable regularity in the disposition of the muscular fibres in its supradorsal membrane. These characters, irrespective of any other points of structure, are sufficient to distinguish this form from the other species of *Hymenaster*.

18. *Hymenaster pullatus*, Sladen (Pl. XCII. fig. 1; Pl. XCIII. figs. 1–3).

Hymenaster pullatus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 235.

Marginal contour more decidedly stellate than pentagonoid. The interbrachial arcs appear to have been well rounded, with the minor radius probably in the proportion of about 57 per cent. R = 35 mm.; r = about 20, but the specimen is unfortunately so much damaged in each of the interbrachial arcs that it is impossible to give the smaller dimen-

sion exactly. Rays well produced, fine and tapering at the extremities. Abactinally the centre of the disk is elevated into a sharp conoid, and the rays are prominently arched.

The supradorsal membrane is very delicate. The spinelets of the paxillæ, which are prominently projecting, very delicate, and tapering towards their extremity, are distributed regularly at uniform intervals apart over the whole abactinal area. Numerous very fine thread-like fibrous bands pass between the tips of the spinelets, crossing over and under one another, but not merging or forming a coherent reticulated structure. The fibres are not tightly stretched between the tips of the spinelets, but slope downward at a high angle like slackened ropes round a tent-pole; in consequence of this and of their great prominence the spinelets appear to superficial examination to stand like well-spaced conical prickles upon the abactinal area. The oscular orifice is of moderate size, the outer margin (from which the valves take their rise) being marked off by prominent sharp spinelets into a pentagon, 9·5 mm. in diameter, the angles opposite to the rays. The valves are very regularly subtriangular, composed of ten to twelve radiating spines, and when closed form a pyramidal peak in the centre of the disk.

The ambulacral furrows are narrow and deeply sunken, constricted near the mouth, widest about the outer third, and then sharply tapering to the extremity. The armature of the adambulacral plates consists of three short, stout, tapering, compressed spines, placed in line oblique to the direction of the furrow, and also to the horizontal plane of the ray. The adambulacral spines are quite hidden in the furrow, not webbed together, but probably invested with a rather long membrane. The aperture-papillæ are large and squarely oval.

The mouth-plates are somewhat broad, short, and almost perpendicular in position; the keel is flattened. Each plate bears two short, thick, secondary or superficial spinelets, the aboral ones being the most robust. One mouth-spine stands above the innermost secondary, and another, much smaller, is placed isolated on the horizontal lateral margin of the plate.

The actino-lateral spines, which are twenty-seven or perhaps about thirty in number, are robust at the extremity of attachment, but very delicate and tapering outwardly, and do not meet in the interradium.

Colour in alcohol, dark purple, with the fibrous bands on the abactinal surface white, which gives a very elegant effect. The ambulacral tube-feet are very dark purple, almost black, with white tips.

Locality.—Station 218. Off the north coast of New Guinea, south-west of the Admiralty Islands. March 1, 1875. Lat. 2° 33′ 0″ S., long. 144° 4′ 0″ E. Depth 1070 fathoms. Blue mud. Bottom temperature 36°·4 Fahr.; surface temperature 84°·0 Fahr.

Remarks.—The structure of the supradorsal membrane, the form and armature of the mouth-plates, and the presence of cross muscular fibres in the web of the actinal floor, serve to distinguish this species from its congeners.

19. *Hymenaster membranaceus*, Wyville Thomson (Pl. XCII. figs. 6 and 7; Pl. XCIII. figs. 10–12).

Hymenaster membranaceus, Wyville Thomson, 1877, Voy. of Challenger, Atlantic, vol. i. p. 108 (name only).

Hymenaster membranaceus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 237.

Marginal contour subpentagonal. Interbrachial arcs wide and flat, the minor radius in the proportion of 62 per cent. or less. R = 35 mm. approximately; $r = 22$ mm. Rays very narrow and tapering on their outer portions. Abactinal area almost flat. Actinal area slightly convex, but deeply incurved along the median interradial lines.

The supradorsal membrane is thin and transparent, with a great number of thin fibrous muscular bands extended between the tips of the paxillæ-spinelets, passing from one to each of those in the vicinity and crossing one another in all directions, but without merging or forming a reticulated tissue in the true sense of the word.

The tissue is semitransparent, with a few isolated spiracula here and there. The tips of the spinelets produce slight prominences, but there is no massing of the tissue or the fibres upon their extremities, which are consequently quite sharp and little conspicuous. The oscular orifice is very large, the outer or basal circumference measuring 12·5 mm. in diameter. Each valve is composed of at least ten radiating spines, their bases of articulation forming a prominent semicircular boss in each radius.

The ambulacral furrows are narrow and deep, scarcely petaloid, although much narrower near the mouth and rapidly tapering at the extremity; the adambulacral plates are high. The armature of the adambulacral plates consists of three very short, stout, slightly tapering and slightly compressed spines, placed high in the furrow, each series standing in line slightly oblique to the median line of the ray, and oblique also to the horizontal plane of the furrow, the innermost spine being highest up in the furrow and most aboral. The spines are not webbed. The aperture-papillæ are very large, and covered with widely expanded membrane, which gives them a squarely oval or subquadrate shape, often with a slight peak.

The mouth-plates are rather small, sloping upward into the mouth, their aboral extremity being tilted downward; a prominent keel occurs along the line of junction, and the internal peak is rounded and very little produced. Each mouth-plate carries two secondary or superficial spines: one short, dumpy, obtuse, compressed, standing on the surface of the plate at about one-third the distance from the adoral extremity, and directed somewhat outward and away from the mouth; the other, rather longer but much less robust, placed quite at the adoral extremity, and rather geniculated sideways; in fact this spinelet might almost be ranked as a mouth-spine proper, except that it stands at a slightly lower level and more on the plate itself. On the horizontal margin of the plate, and situated on the widely expanded lateral flange, are four or five small compressed mouth-spines, very much smaller than those just described, and similar to the spines on the adambulacral plates, only smaller in size.

The actino-lateral spines, although long, do not meet in the interradium; indeed the abactinal and actinal membranes coalesce, apparently normally, in the outer portion of the median interradial line, thereby forming a partition in the interradial chamber. The spines which come near the interbrachial margin are much thickened and knobbed at their extremity; indeed all of them are more or less so except the most outward of all. There are about thirty-two to thirty-six actino-lateral spines, the fifteenth to seventeenth from the mouth being longest; beyond this they diminish very rapidly in size.

Colour in alcohol, white.

Locality.—Station I. South-west of Cape Finisterre. December 30, 1872. Lat. 41° 58′ 0″ N., long. 9° 42′ 0″ W. Depth 1125 fathoms. Blue mud.

Remarks.—*Hymenaster membranaceus* bears some superficial resemblance to *Hymenaster pullatus*, but the forms may be readily distinguished by the character of the supradorsal membrane, by the form and armature of the mouth-plates, by the shape of the aperture-papillæ, and by the structure of the web of the abactinal floor.

20. *Hymenaster coccinatus*, Sladen (Pl. XC. figs. 3 and 4; Pl. XCI. figs. 10–12).

Hymenaster coccinatus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 238.

Marginal contour stellato-pentagonoid. Interbrachial arcs well rounded. Rays tapering to a fine point, with their lateral margins almost straight. Minor radial proportion 55·5 per cent. R = 18 mm.; r = 10 mm. Form very depressed, slightly convex and rising in the centre. No definite marginal fringe present.

The supradorsal membrane is very fine; the muscular fibres are thin, filiform, and well defined, forming a rather wide and rectangular reticulation resembling to a large degree the venation of certain leaves more than the characteristic intercrossing of fibres radiating from the neighbouring spinelets which is generally noticeable throughout the genus. This peculiarity arises from the frequent bifurcations, bendings, and sudden terminations to which the fibres are subject, which, together with the presence of small secondary fibres, modify the normal arrangement of radiation from tip to tip, this being after all the principle of the disposition of this structure even in the species under notice. The meshes are filled in with an almost hyaline tissue, punctured with two, three, or even more small spiracula, each surrounded with a definite white ring. The spinelets of the paxillæ are not numerous, and are but slightly protuberant, the tips being covered with a little cap of membrane, which gives them a rather knobby appearance. The oscular orifice is moderately large, its outer circumference at the base of the valves being well defined by a pentagonal outline formed of thickened or fibrous tissue. The five valves are regular and triangular, with about eight spines in each; the whole series are webbed together, and form a very slightly elevated pyramid when closed.

The ambulacral furrows, which are wide and open, are very slightly petaloid opposite the commencement of the outer third, and rather rapidly constricted towards the tip.

The armature of the adambulacral plates consists of four (but often towards the extremity only three), short, delicate, acicular, and well-spaced spines. Three stand on the margin of the plate parallel to the furrow, the aboral being the smallest and the adoral nearly twice as long. The fourth spine, which is equal in length to the last-named, or even longer, is placed close to it, but on the outer side and away from the furrow. These two spines are present throughout the ray, and maintain this position. The three marginal spines are usually stretched horizontally over the furrow, but the fourth spine is almost perpendicular, and frequently radiates at an angle outward (away) from the furrow. The spines are covered with an investing membrane, which in the three marginal spines is expanded towards the tip and gives them a claviform appearance, the most adoral one of the three being more robust than the others; in the fourth or outward spine the investment is even more developed, and the covered spine presents a somewhat more lanceolate shape than those just referred to. The aperture-papillæ are very singular in form, and consist of a comb of about five to seven radiating spinelets springing from a common base, the central spinelet being straight and much longer than the others, which are curved, the two outer ones forming together a regular semicircular span, and the rest radiating within this curve, at gradually lessening angles of divergence from the central spinelet. The investing membrane by which the papilla is covered owes its form in a great measure to this skeleton. It is ovate or oblate basally, with an elongate acicular prominence in its outward prolongation. Near the extremity of the ray this central shaft of the papilla is greatly lengthened, being little shorter than the lateral spines.

The mouth-plates are short, but extraordinarily broad, the lateral flanges being developed to an abnormal extent. The keel at the junction is feebly represented, only flatly rounded, slightly prominent aborally, the adoral peak being well developed. One moderately robust, short, conical spinelet, very wide at the base, sharply pointed, and covered with membrane, is placed near to the adoral extremity of each plate, and rather above the actual margin. No other secondary or superficial spine is present. There are three mouth-spines, about equal in size to the spines of the adambulacral armature, placed on the extreme outer portion of the lateral flange, and sometimes the outer one is doubled.

The actino-lateral spines are delicate and well spaced. Sixteen are present on each side of a ray, the third or fourth from the mouth being usually the longest, and the rest gradually diminishing in size as they approach the extremity of the ray.

Colour in alcohol, abactinal surface white, with the faintest shade of pink; actinal surface scarlet; ambulacral tube-feet white.

Locality.—Station 146. Between Marion Island and the Crozet Islands. December 29, 1873. Lat. 46° 46′ 0″ S.; long. 45° 31′ 0″ E. Depth 1375 fathoms. Globigerina ooze. Bottom temperature 35°·6 Fahr.; surface temperature 43°·0 Fahr.

Remarks.—The almost venated character of the disposition of the muscular fibres in the supradorsal membrane, the peculiar character of the armature of the adambulacral

plates, the remarkable structure of the aperture-papillæ, and the widely expanded and simply armed mouth-plates in *Hymenaster coccinatus*, apart from its rich colouration, readily distinguish the species from all other forms.

21. *Hymenaster præcoquis*, Sladen (Pl. XC. figs. 5 and 6 ; Pl. XCI. figs. 13–15).

Hymenaster præcoquis, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 240.

Marginal contour subpentagonal. Interbrachial arcs very feebly incurved, the rays slightly attenuated at their extremities. Minor radial proportion 65 per cent. R = 10 mm. ; $r = 6{\cdot}5$ mm. The abactinal surface forms a uniform convex curve of low elevation, the membrane arching over from margin to margin, and the radial areas being in no way specially defined externally. No lateral fringe present. Actinal surface flat.

The supradorsal membrane is very fine and semitransparent. The muscular tissue is very feebly developed, no definite series of fibrous bands being present, although under considerable magnification the existence of aggregated fibres may be discerned. The spiracula are comparatively large, numerous, and equally distributed, surrounded by a conspicuous white ring. The paxillæ are large, robust, closely placed, and usually surmounted with five (sometimes six or seven) spinelets, which are thick and widely expanded from the pedicle. The spinelets do not taper at their extremities, but expand somewhat, and are flaring, elevating the membrane very slightly. The paxillæ are clearly visible through the transparent membrane, and about nine longitudinal rows may be counted across the base of the ray. The oscular orifice is small, with the spines of the valves long and slightly tapering.

The ambulacral furrows are narrow and lanceolate, maintaining a nearly uniform breadth till near the extremity. The armature of the adambulacral plates consists of three to five rather long, delicate, and acicular spines, arranged on the plate in a semicircular curve when the larger number are present—three usually being on the margin of the furrow, and the two adoral ones standing successively more outward (away from the furrow) on the plate. These two obliquely placed spinelets maintain their position throughout the rays, and any diminution which takes place in the number towards the extremity is manifest in the marginal or aborally placed members of the series. The most aboral spine is rather shorter than the others, which are nearly uniform in length, and each of them is invested with a very thin membrane, and no sacculus is produced. The first adambulacral plates (nearest the mouth) bear only two spines, and these sometimes are webbed together.

The aperture-papillæ are small and dumpy, the calcareous portion being little more than twice (or at most three times) as long as broad, and very frequently this is bulged out somewhat at the side. The papilla is not free as usual in this genus, but is clothed with the general tissue of the actinal area, the aboral lateral margin alone being free and

forming the actual lip of the segmental aperture as in *Pteraster*, the papilla being fixed close up to the spine, aboral to it, and slants rather obliquely in consequence.

The mouth-plates are small, short, narrow, both plates elevated prominently rather than forming a true keel at the junction; aboral extremity gently rounded, not prominent. Each plate bears two large, robust, conical secondary or superficial spinelets, which are longer than the plates themselves, taper to a fine point, and owing to the breadth of their bases occupy nearly the whole of the length of the short plate. These spines stand perpendicularly to the superficies of the plates, the aboral pair radiating rather wider apart and more outward than the adoral pair. The mouth-spines, which are two (or three?) in number, are delicate, pointed, rather wide apart, and placed on the lateral margin of the plates opening into the actinostomial circle.

The actino-lateral spines are comparatively robust and well spaced, sixteen or seventeen are present on each side of the ray, the fifth from the mouth being longest; they are slightly tapered at their extremity, and just protrude beyond the margin, which is feebly festooned between.

Colour in alcohol, greyish white, nearly transparent.

Variation.—In a specimen from Station 147, four seems to be the normal number of spinelets in the adambulacral armature, the adoral one being relatively smaller, and the transverse tendency of the series upon the plate being even more marked than in the specimen from which the above description is taken. In this specimen (from Station 147) an additional pair of superficial secondary mouth-spines is present, making three pairs, and the innermost pair of mouth-spines proper are nearly as large as the adoral pair of secondaries.

Localities.—Station 146. Between Marion Island and the Crozet Islands. December 29, 1873. Lat. 46° 46′ 0″ S., long. 45° 31′ 0″ E. Depth 1375 fathoms. Globigerina ooze. Bottom temperature 35°·6 Fahr.; surface temperature 43°·0 Fahr.

Station 147. West of the Crozet Islands. December 30, 1873. Lat. 46° 16′ 0″ S., long. 48° 27′ 0″ E. Depth 1600 fathoms. Diatom ooze. Bottom temperature 34°·2 Fahr.; surface temperature 41°·0 Fahr.

Remarks.—*Hymenaster præcoquis* differs so widely from all other species of *Hymenaster* in the character of the adambulacral armature and of the aperture-papillæ, that I have felt some doubt as to whether they do not require the separation of the form in a subgenus, or even a distinct genus. After carefully considering the importance attributable to these structures, I have decided to leave for the present the species as now classed. One of the examples of this species is exceedingly interesting from the fact that well-developed young are present in the nidamental chamber, and may be seen through the semitransparent membrane. A large rent occurs in the actinal floor in one interradium, and I am inclined to think that it was probably formed for their egress; but whether by the young starfishes themselves or by their mother, I am unable to offer an opinion.

Genus *Benthaster*, Sladen.

Benthaster, Sladen, Journ. Linn. Soc. Lond. (Zool.), 1882, vol. xvi. p. 242.

Form depressed. Marginal contour stellato-pentagonoid. Abactinal area convex. Actinal area plane.

Supradorsal canopy rudimentary. No muscular fibrous bands. No spiracula. Nidamental cavity more or less aborted. Paxillæ with subfascicular crowns; spinelets trilaminate, of extraordinary length, delicacy, and number, protruding the greater portion of their length naked beyond the supradorsal membrane. Paxillæ probably devoid of investing membrane. Papulæ simple, globular, sessile sacs, comparatively large. Special dorso-lateral (? supero-marginal) plates at the extremities of the rays. Ossicles of the abactinal surface cruciform, greatly attenuated, the whole calcareous framework being reduced to a minimum.

Adambulacral armature consisting of one or two spinelets, which are long, needle-shaped, independent, and not united by membrane. Aperture-papillæ more or less modified. Segmental apertures (?) aborted.

Mouth-plates of the *Hymenaster* type. Two pairs of secondary or superficial mouth-spines, robust, clavate, thorny, probably without saccular membrane. Mouth-spines proper two or three, the innermost resembling the anterior pair of secondaries, only rather smaller, the others pointed.

Actino-lateral spines merged in the actinal floor.

Remarks.—The superficial aspect of this genus recalls, to a certain extent, that of *Korethraster*, from which, however, it is structurally widely separate. The rudimentary supradorsal membrane, and the long, fasciculated, naked, paxillar spinelets, protruding far beyond the membrane, readily distinguish the genus from *Hymenaster*; whilst the simple independent armature of the adambulacral plates, not forming combs and not webbed, at once distinguishes *Benthaster* from *Marsipaster*, the only other form with which it can be compared.

Chorology of the Genus Benthaster.

α. *Geographical distribution*:—

Pacific: Two species between the parallels of 40° N. and 10 S.

Benthaster wyville-thomsoni, from the Mid-North Pacific, near the meridian of 170° E. *Benthaster penicillatus*, off the north coast of New Guinea, south-west of the Admiralty Islands.

β. *Bathymetrical range*: 1070 to 2900 fathoms.

γ. *Nature of the Sea-bottom*: *Benthaster wyville-thomsoni* on Red clay; *Benthaster penicillatus* on Blue mud.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Benthaster penicillatus . .	Pacific.	1070	Blue mud.
Benthaster wyville-thomsoni . .	Pacific.	2900	Red clay.

1. *Benthaster wyville-thomsoni*, Sladen (Pl. XCIV. figs. 1–5).

Benthaster Wyville-Thomsoni, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 242.

Marginal contour substellate. Rays broad at the base and tapering to a very fine extremity. Interbrachial arcs well indented, not rounded; the minor radius in the proportion of 50 per cent. R = 18 mm.; r = 9 mm. General body-profile much depressed, slightly elevated in the centre of the disk.

The abactinal aspect is very remarkable, recalling at first sight the appearance of *Korethraster*. This resemblance, however, is merely illusory, and arises from the presence of prominent tufts of long spinelets that project free beyond the supradorsal membrane. The pedicels of the paxillæ are comparatively short, reduced almost to tubercles on the outer part of the rays, bearing about eight to ten spinelets, which are of great length, and expand very slightly apart from one another. The paxillæ stand on cruciform ossicula, the prolongations of which are very long and thin, and the central portion where they cross little, if at all, widened.

The supradorsal membrane is represented by a loose irregular spongiform tissue, which fills up the paxillæ-crowns near their bases, and extends over the whole abactinal area. This spongy mass is not uniform in thickness or density, and nowhere forms a definite membrane. The paxillæ-spinelets protrude a great portion of their length through this tissue, and have the appearance of being entangled amongst it,—a conventional definition of their character expressing more than any rigid description of this part of the structure. No muscular fibrous bands, and no spiracula are present. The spinelets, which are transparent and vitreous in appearance, are regularly trilaminate (as may be distinctly seen in every broken section) and taper to a fine sharp point. No trace is apparent of any true membranous envelope to the paxillæ. The spinelets on the disk are much longer and more robust than elsewhere, attaining their greatest size in the neighbourhood of the centre. The oscular orifice is rather indistinct, margined by five somewhat irregular tufts or spinelets, longer and more robust than any of the others. No definite or regular valves appear to be formed. It is doubtful to what extent the dermal chamber is

developed, but probably its character is greatly modified; the specimen under notice leads to the inference that it is almost aborted in the present instance.

At the extremities of the rays there is on each side an elongate supero-marginal plate, equal in length to about seven or eight segments of the ray, becoming thicker at the aboral end and developing more or less of a knob. These expansions join at the extremity of the ray, and form an arch over the termination of the ambulacral furrow, the knobs bearing several prominent spinelets stouter than any of those in the vicinity.

The ambulacral furrows are broad and rather petaloid. The tube-feet are arranged in simple pairs. The adambulacral plates are very narrow and spaced widely apart, the margin of the furrow being simply a narrow ridge. Their armature consists normally of two spines, placed transversely and very slightly oblique, but frequently only one is present. They are long, thickened at the base, tapering to the point; and when two are present, the outer one is often much larger than its companion. No trace of any investing membrane is present. Squamous plates are present on the outer margin of the adambulacral plates, which doubtless are the representatives of the aperture-papillæ. They seem to be more or less aborted functionally in the specimen under notice, and are apparently ankylosed, at any rate on the inner half of the ray, to the general body-skeleton; they are large, and broadly oval or subspatulate in shape.

The mouth-plates resemble in character those of *Hymenaster*. The median keel along the suture is very prominent adorally and sharply rounded. Two short, robust, curved, slightly clavate, and rather thorny spinelets stand on each side of the keel near the middle of the plates. Owing to the bad state of preservation of this specimen, the rest of the armature is unfortunately undistinguishable.

The actino-lateral spines, which are fifteen to twenty in number, or perhaps rather more, are comparatively short, delicate, and widely spaced; the longest is about the fourth from the mouth, and rather shorter than the breadth of the ambulacral furrow, measured from the base of this spine to the base of its correspondent on the opposite side. The actino-lateral spines do not diminish very rapidly in length as they approach the extremity. A fibrillar tissue of very loose construction forms the web uniting the spines, and at the same time constitutes the actinal floor of the test, beyond the margin of which the spines project considerably. In places where the actinal web has been removed in the interradial space, no paxillæ are to be seen for supporting the pseudo-supradorsal membrane from the sides of the rays, the cavity appearing to be very feebly developed there.

Locality.—Station 244. In the Mid-North Pacific, between Yeddo and San Francisco, near the meridian of 170° E. June 28, 1875. Lat. 35° 22′ 0″ N., long. 169° 53′ 0″ E. Depth 2900 fathoms. Red clay. Bottom temperature 35°·3 Fahr.; surface temperature 70°·5 Fahr.

2. *Benthaster penicillatus*, Sladen (Pl. XCIV. figs. 6–9).

Benthaster penicillatus, Sladen, 1882, Journ. Linn. Soc. Lond. (Zool.), vol. xvi. p. 245.

Marginal contour stellato-pentagonoid; interbrachial arcs moderately indented and well rounded. Minor radial proportion 65·2 per cent. R = 11·5 mm.; $r = 7{\cdot}5$ mm. The rays taper gradually, and their extremities are somewhat upturned.

The supradorsal membrane is exceedingly delicate and rudimentary, appearing little more than a thin mucous film over the interradial areas, becoming, however, rather spongiform over the rays. The pedicles of the paxillæ are very thin and delicate, bearing a crown of extremely long, thin, needle-like spines, seven or eight times the length of the pedicle; there are about twenty spinelets in a crown on the disk, and about half that number, or less, towards the extremities of the rays. The spinelets are of the most delicate description, vitreous in appearance, trilaminate, the transverse section representing three cylindrical rods placed together, instead of three flattened laminæ, as in the preceding species. The spinelets are widened at their proximal extremity into a condyloid articulatory base, all fitting close together, and each moulded to the form of its fellows, the whole forming a compact basement to the crown. The spinelets constituting a crown expand very slightly apart, and protrude the greater portion of their length free and naked through the supradorsal membrane.

The cruciform ossicles of the abactinal surface, upon which the paxillæ are borne, are very delicate, the prolongations being attenuated to a remarkable degree, here and there almost aborted, and the central portion of the ossicle manifesting a tendency to become rotund and squamiform. This modification is so far carried out, that in the centre of the disk the whole of the abactinal surface that can be seen under the oscular orifice is simply covered with subcircular scales.

The oscular orifice is very large. The valves (or their representatives) consist of a compressed paxilla-crown composed of rather more robust spinelets than the rest. The pedicles of these modified paxillæ are very much enlarged, compressed laterally, and expanded at the top, upon which the spinelets are articulated in a more or less regular double row, the pedicles standing in the median radial line. Powerful muscular bands run between the bases of the pedicles of the valves and form a regular pentagon, near the centre of which the anal aperture is situated. Close to the periproct and less than its own breadth away is the remarkably small, round, insignificant, madreporiform body. The papulæ are simple round sacs, as broad as long, and immensely large in proportion to the pedicles by which they stand.

Supero-marginal plates are present at the extremity of the ray, and form a terminal arch or ocular guard; but they are not half the length of the similar pieces in the preceding species.

The ambulacral furrows are wide, not petaloid, and the margins of the furrow are very narrow. The armature of the adambulacral plates consists of two or three spines

placed very obliquely, the inner or aboral spine being the smallest; the outermost spine is probably the representative of the aperture-papilla, of which it occupies the place, although it differs in no way from the other two spinelets; sometimes a small additional spinelet is present. The spines are long, delicate, and needle-shaped, and there are traces of a fine investing membrane.

The mouth-plates are of the *Hymenaster*-type, and present a prominent peak aborally, sloping adorally, and little prominent in front. Each plate bears two long, clavate, thorny, somewhat curved secondary or superficial spines, nearly equidistant from one another and from the median suture, the posterior spinelets being longest. Two mouth-spines proper are situated on the horizontal margin of each plate, the innermost one being slightly smaller than the anterior secondary (superficial) spine, which it resembles exactly both in form and character; whilst the outer spinelet is very much smaller, and slightly tapering and smooth, instead of being clavate and thorny.

The actino-lateral spines are delicate and rather widely spaced; about fifteen are present on each side of a furrow, the fourth or fifth from the mouth being longest. The spines diminish slowly in size as they proceed outward, and maintain a fair length even at the extremity of the ray. The actinal membrane is perfectly transparent, and composed of very fine and widely spaced fibres, reticulated rather rectangularly. No marginal fringe is formed; and the actinal tissue appears to pass over the margin continuous with the supradorsal tissue. The actino-lateral spines project considerably beyond the margin, and are naked.

Colour in alcohol, greyish white.

Locality.—Station 218. Off the north coast of New Guinea, south-west of the Admiralty Islands. March 1, 1875. Lat. 2° 33′ 0″ S., long. 144° 4′ 0″ E. Depth 1070 fathoms. Blue mud. Bottom temperature 36°·4 Fahr.; surface temperature 84°·0 Fahr.

Subfamily Pythonasterinæ, Sladen, 1888.

Genus *Pythonaster*, Sladen.

Pythonaster, Sladen in Narr. Chall. Exp., 1885, vol. i. p. 609.

Rays very elongate and flexible, swollen for a short distance from the disk, then rapidly becoming narrow, compressed laterally and extending to an attenuate extremity. Disk small, with a well-defined channel traversing each interradial line, which causes the starfish to appear to be composed of five united rays only. In the central abactinal region are five triangular fan-like valves, composed of delicate spinelets united by membrane, radial in position, which meet together when shut down and cover the dorso-central aperture.

Abactinal and lateral surfaces beset with delicate plates imbedded in membrane and

invisible without microscopic preparation; they bear fasciculi of minute spinelets enveloped in a membranous sac, which causes them to appear like little semiglobular bags only. These sacculi are arranged with great regularity on each side of the median radial line in obliquely transverse lines, which pass up to the adambulacral plates. Along the median line of the ray is a band of smaller and irregularly disposed sacculi.

Adambulacral plates large. Armature consisting of an obliquely transverse series of spinelets united by membrane and forming a semicircularly curved fan.

Mouth-plates with a prominent median keel. Armature consisting of:—(1.) A marginal series of three or four mouth-spines webbed together, and about three smaller ones not webbed together. (2.) On the actinal surface of the plate, two larger secondary mouth-spines in membranous sheaths. The actinostome is very wide, and there is a broad exposed buccal membrane.

Madreporiform body situated in one of the interradial sulci, external to the dorsocentral valvular apparatus. Surface grooved with numerous rather coarse striations.

Ambulacral tube-feet large and biserially arranged, with a large, fleshy, centrally-invaginated, button-like terminal disk.

No pedicellariæ of any kind are present.

Remarks.—This remarkable and abnormal type of asterid is altogether unlike any other form. Its general morphological structure appears to me to justify its inclusion in the family Pterasteridæ. Its aberrant peculiarities, however, necessitate in my opinion its separation in a distinct subfamily.

Chorology of the Genus Pythonaster.

α. *Geographical distribution:*—

ATLANTIC: One species between the parallels of 30° and 40° S.

Pythonaster murrayi, off the coast of South America, east of Buenos Ayres.

β. *Bathymetrical range:* 1900 fathoms.

γ. *Nature of the Sea-bottom:* Blue mud.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Pythonaster murrayi . .	Atlantic.	1900	Blue mud.

1. *Pythonaster murrayi*, n. sp. (Pl. XCV. figs. 1–5).

Rays five. R = 150 mm.; r = 17 mm. R < 9 r. Breadth of a ray at the base, 19 mm.; breadth at 19 mm. from the base, 9 mm.; midway between the centre and the extremity, 5·5 mm.

Rays very elongate, flexible, narrow, subcylindrical, subcarinate and compressed laterally on the outer part, considerably swollen and inflated at the base but rapidly becoming slender at a short distance from the disk; they then appear to maintain a nearly uniform breadth for some distance along the ray, and finally taper gradually to an attenuate extremity.

A transverse section of the ray, midway between the centre and the extremity, would present an outline nearly resembling that of a gothic arch, with the apex slightly rounded, the vertical height being greater than the breadth. The lateral walls terminate with an abrupt rounding upon the actinal surface, this rounding being occupied entirely by the adambulacral plates; nearly the whole of the actinal surface of the ray is thus taken up by the ambulacral furrow.

The disk is small, and its real size is so much masked that the starfish has the appearance of being composed of five united rays only, the deception being produced by the presence of a deep sulcus or channel, which traverses each interradial line. This constriction emphasises the swelling at the base of the ray, and also causes the ray to appear to be continued nearly to the centre of the disk. In the central area there is some depression, in the midst of which is located a well-developed valvular apparatus similar to that closing the oscular orifice in the Pterasteridæ. This consists of five triangular fan-like valves, radial in position, each composed of delicate spinelets united by membrane, which meet together when shut down and completely close the dorso-central aperture.

The abactinal and lateral areas are beset with extremely delicate plates, which are imbedded in membrane and are invisible without microscopic preparation. The ornamentation of these surfaces presents a very remarkable appearance. It consists of short, minute spinelets, grouped together into fasciculi, five to ten in each, borne on the plates above mentioned; and each fasciculus is enclosed in a membranous sac, which causes them to appear like little semiglobular bags only. Under magnification the extremities of spinelets may here and there be seen protruding through the membrane, and the interspaces are also covered with membrane. The fasciculi are arranged with great regularity in obliquely transverse lines on each side of the median radial line, and pass along the deep lateral wall of the ray up to the adambulacral plates. In the median portion of the radial areas of the disk and along the median line of the ray, the sacculi are smaller and are disposed without order and consequently independent of the transverse series. This irregular median band is very narrow along the ray, but expands towards the base and on the radial area of the disk. The rows run nearly parallel to the interradial line, and maintain the

same angle of obliquity with scarcely any change throughout the ray. One of the lineal series at the base of the ray contains about fifteen or sixteen sacculi in a line, which are closely placed and often touch one another. The sacculi diminish in size as they proceed along the ray, and midway between the centre and the extremity there are about six or seven in a row. The series of rows are separated from adjacent rows by a well-defined space, nearly as broad as the row of sacculi. The interradial sulcus, above mentioned, is emphasised and almost arched over by the row of sacculi on each side. As these two rows pass over the margin, they recede gradually from the median line as they approach the adambulacral plates, in consequence of which a wedge-shaped naked area occurs along the interradial region on the actinal surface, extending between the mouth-plates and the margin, where it narrows into the sulcus that proceeds along the abactinal surface. Sometimes one or two sacculi may be present on each side of the median line a short distance behind the mouth-plates.

The armature of the adambulacral plates is arranged in obliquely transverse semicircular curves, and consists near the inner end of the furrow of about six spinelets, the outermost being longest and the rest decreasing gradually in size as they approach the inner or aboral end of the series, and all are united by membrane which is deeply indented between the two outer spinelets, and to a less degree between the others. On the outer part of the ray the number of spinelets is reduced to five or four. The inner two or three spinelets are minute, and stand close together on that part of the semicircle which traverses the furrow-margin of the plate, the curvature of the base line of the fan having its convexity directed adorally. The longest spinelets have a tendency to radiate outward, and the adambulacral plates present a slight angular prominence into the furrow.

The mouth-plates are large and prominent, with a rounded elevated ridge along their line of junction, terminating aborally in a moderately prominent peak. The plates have broad lateral expansions, the adoral margin being nearly as long as the median suture; they protrude but slightly into the margin of the actinostome, and there is only a feebly-developed peak at the adoral extremity of the median juncture. The armature consists of three or four short, cylindrical mouth-spines placed on the horizontal margin of each plate, united by membrane and directed towards the interradial line, the innermost spine being the longest. Immediately succeeding the mouth-spines are three small spinelets situated at the angle of the plate most remote from the median line of juncture; the innermost stands close to the mouth-spines and might be counted as one of that series, except that it is not connected with them by membrane as the others are; the other two spines are behind, and form with the one just mentioned a semicircular curve at the rounded angle of the mouth-plate, suggestive of an incipient adambulacral armature. These spines, however, are much smaller, and though covered with membrane are not united. Upon the surface of each plate, near the median elevation, are borne two

secondary or superficial mouth-spines, which are longer than the mouth-spines proper; the most aboral is the longer and stands at about one-third of the distance from the adoral extremity of the plate; the second is smaller and is placed close behind the marginal series of mouth-spines. All these spinelets, both mouth-spines proper and secondaries, are covered with membranous sheaths, which in the case of the large aboral secondary spines are widely expanded at the base. The mouth-spines are united by a membranous web, but there is no connection between the armature of the two united plates.

The actinostome is large, occupying nearly two-fifths of the actinal surface of the disk, the mouth-plates consequently could not be apposed, and the mouth is situated in the centre of a naked leathery membrane, and is furnished with a well-developed muscular lip, the delicate and regular plications of which give a very elegant appearance to this structure. Near the margin of the actinostome the membrane is semitransparent, and the internal viscera may be indistinctly traced through it.

The dorso-central valves when closed form as a whole an externally subcircular button from 6 to 7 mm. in diameter. The valves are triangular and composed of delicate spinelets, a dozen or more in each, united together by membranous web. The spinelets decrease in length regularly from the central ones in each fan-like valve; and the membrane is gracefully festooned between the extremities of the spines. Externally there is an abrupt flexure of the fan at its base, which gives the button-like character to the apparatus already noticed. Some vesicular protuberances are visible through the spaces left between adjacent valves, but I am unable, without an undesirable mutilation of the specimen, to offer any positive observation as to whether these valves open into a definite infradermal cavity; my impression is that such a cavity does not exist in this form. A protuberant anal membrane appears to be traceable.

The madreporiform body is moderately large and situated in the interradial sulcus, external but close to the dorso-central valves; the striations are numerous but rather coarse, and radiate with considerable regularity from the centre.

The ambulacral tube-feet are large and regularly biserial. They are furnished with a large fleshy sucker-disk, which, when viewed laterally, is seen to be of greater diameter than the immediately adjoining part of the tube, and from which it is marked off by a well-defined constriction. The sucker-disk has consequently the character of a button-like extremity; and in the centre there is a conspicuous invaginated depression.

Colour in alcohol, a uniform yellowish ashy grey.

Locality.—Station 323. Off the coast of South America, east of Buenos Ayres. February 28, 1876. Lat. 35° 39′ 0″ S., long. 50° 47′ 0″ W. Depth 1900 fathoms. Blue mud. Bottom temperature 33°·1 Fahr.; surface temperature 73°·5 Fahr.

Family Echinasteridæ, Verrill, 1871 (1867), *emend.*

The family Echinasteridæ established by Verrill[1] comprised the genera *Echinaster*, *Acanthaster*, *Mithrodia*, and *Ferdina*. In 1875 Perrier[2] added to this group *Solaster* (including *Crossaster*), *Cribrella*, and *Valvaster*, and removed the genus *Ferdina* to the family Linckiidæ. In 1878 Viguier[3] maintained the family as thus constituted, but divided the genera into four "tribus," the Echinasterinæ, Mithodiinæ, Valvasterinæ, and Solasterinæ, the last embracing the genera *Solaster* and *Acanthaster*. In 1884 Perrier[4] removed *Solaster* (recognising the independent genera *Solaster*, *Crossaster*, and *Lophaster*), which he placed in a distinct family Solasteridæ, and *Mithrodia*, which he also ranked in a separate family. With the latter step I am unable to agree, and I have therefore replaced the Mithrodiinæ as a subfamily of Echinasteridæ. With this exception I maintain the generic constitution of the family as last amended by Perrier.

I have added two new genera to the family—*Perknaster*, a form allied to *Cribrella*, and *Plectaster*, a genus established for the reception of the remarkable species described by Müller and Troschel[5] under the name of *Echinaster decanus*, which has since been erroneously referred by Perrier[6] to the genus *Solaster*. I have recently had the gratification of identifying the species in some examples sent to the British Museum from Port Jackson and Port Phillip, respecting which Prof. Jeffrey Bell[7] has subsequently published a brief note recording the new occurrence of this interesting type. *Plectaster*, n. gen., is characterised by the wide-meshed reticulate arrangement of the abactinal plates, which leave enormous papular areas occupied by numerous papulæ (fifty or more may be counted in a large mesh, and the surrounding margin of the membrane perforated by the papula is often papillate); by the abactinal plates bearing compact groups of short, equal, upright spinelets imbedded in a membranous mass; by the presence of actinal intermediate and infero-marginal plates (the latter slightly larger) similarly armed with short, equal, upright spinelets invested in a sacculate membranous bag, which in spirit specimens has the appearance of being deeply invaginated or perforated in the centre; by the armature of the adambulacral plates, consisting of two parallel semicircular series of short, equal, cylindrical spinelets, four or five in each series, standing upright and palisade-like. *Plectaster decanus* has a remarkable facies unlike that of any other form with which I am acquainted.

[1] *Trans. Conn. Acad. Arts and Sci.*, 1871 (1867), vol. i. part 2, p. 343.
[2] Révis. Stell. Mus., p. 35 (*Archives de Zool. expér.*, 1875, t. iv. p. 299).
[3] *Archives de Zool. expér.*, 1878, t. vii. p. 93.
[4] *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi. p. 164.
[5] *Archiv f. Naturgesch.*, 1843, Jahrg. ix. Bd. i. p. 114.
[6] *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi. p. 78.
[7] *Zoologischer Anzeiger*, March 1888, Jahrg. xi. p. 121.

Synopsis of the Genera included in the Family ECHINASTERIDÆ.

A. Disk large. Rays numerous. Armed with large isolated spines covered with membrane beset with calcareous granules. Numerous madreporiform bodies. Forficiform pedicellariæ present . . . . ACANTHASTERINÆ.
  a. A single genus . . . . . *Acanthaster.*
B. Disk small. Rays usually five. Armed with large spines beset with scales or asperities. One madreporiform body. No pedicellariæ present. No interbrachial partitions . . . . . MITHRODIINÆ.
  a. A single genus . . . . . *Mithrodia.*
C. Disk small or medium-sized. Rays five or six. Spinulation small: spinelets isolate or grouped. No pedicellariæ present . . . . . ECHINASTERINÆ.
  a. Armature of the adambulacral plates simple or disposed in transverse series.
    a. Abactinal plates bearing small spinelets, in more or less compact groups.
      α. Disk small. Marginal plates usually distinguishable. Adambulacral plates with a small inner spinelet placed high in the furrow . . . . . *Cribrella.*
      β. Disk comparatively large. Marginal plates superficially undistinguishable. No small inner spinelet on the adambulacral plates . . . . . *Perknaster.*
    b. Abactinal plates bearing simple isolated spines . . . . *Echinaster.*
  b. Armature of the adambulacral plates disposed in a double longitudinal series. Abactinal plates forming a wide-meshed network and bearing compact groups of spinelets . . . . . *Plectaster.*
D. Disk moderately developed. Rays five. Abactinal plates regularly disposed, bearing small isolated spinelets. Marginal plates with large valvate pedicellariæ. Actinal intermediate plates bearing one or more large flattened spinelets . . . . . VALVASTERINÆ.
  a. A single genus . . . . . *Valvaster.*

Subfamily ACANTHASTERINÆ, Sladen, 1888.

Genus *Acanthaster*, Gervais.

Stellonia (*pars*), Agassiz, Mém. Soc. Sci. Nat. Neuchatel, 1835, t. i. p. 191.
Echinaster, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 281.
Acanthaster, Gervais, Dict. Sci. Nat., suppl., 1841, t. i. p. 474.
Echinites, Müller and Troschel, Archiv f. Naturgesch., 1844, Jahrg. x., Bd. i. p. 180.

Acanthaster is a very isolated type, having a facies altogether unlike that of any other form. The genus is confined to tropical waters, and, though ranging over a wide area of distribution, the amount of morphological plasticity exhibited is very slight. I feel some uncertainty as to whether the form from Mauritius, so carefully described by de Loriol,[1] can really be recognised as a species independent from *Acanthaster echinites;* and I am equally doubtful as to the validity of the claims of *Acanthaster ellisii.*

[1] *Mém. Soc. Phys. et Hist. Nat. Genève*, 1885, t. xxix., No. 4, p. 6.

Chorology of the Genus Acanthaster.

α. *Geographical distribution*:—

INDIAN OCEAN: One (or perhaps two) species between the parallels of 30° N. and 30° S.

**Acanthaster echinites* and *Acanthaster mauritiensis* from Mauritius, the former also from the Red Sea, and extending into the Eastern Archipelago and the Pacific.

EASTERN ARCHIPELAGO: One species between the parallels of 20° N. and 20° S.

**Acanthaster echinites*, from the Philippine Islands, the Moluccas, and other islands in the archipelago, and extending into the Indian Ocean and the Pacific.

PACIFIC: Three (?) species between the parallels of 30° N. and 55° S.

**Acanthaster echinites*, from the Fiji Islands, and extending into the Eastern Archipelago and Indian Ocean. *Acanthaster ellisii*, from the Galapagos Islands and coast of California; also from New Hanover and New Britain (*fide* Studer). *Acanthaster solaris*, from the Strait of Magellan.

β. *Bathymetrical range*: Confined to the Littoral zone so far as at present known.

γ. *Nature of the Sea-bottom*: Recorded in very few cases; *Acanthaster echinites* inhabits coral reefs.

The species collected by the Challenger is indicated by an asterisk in the above list.

Chorological Synopsis of the Species herein mentioned.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Acanthaster echinites . .	{ Indian, Pacific, and Eastern Archipelago. }	Shallow water.	Coral reefs.

1. *Acanthaster echinites* (Ellis and Solander), Lütken.

Asterias echinites, Ellis and Solander, 1786, Nat. Hist. Zooph., tab. lx., lxi., lxii.
Stellonia echinites, Agassiz, 1835, Mém. Soc. Sci. Nat. Neuchatel, t. i. p. 192.
Echinaster Ellisii (? *pars*), Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 281.
Acanthaster echinus, Gervais, 1841, Dict. Sci. Nat., suppl., t. i. p. 474.
Echinaster solaris, Müller and Troschel, 1842, System der Asteriden, p. 25.
Acanthaster echinites, Lütken, 1871, Videnskab. Medd. naturh. Foren. i Kjøbenhavn, p. 292.

Localities.—Zebu, Philippine group. On the reefs. Depth and conditions not recorded.

Kandavu, Fiji Islands. On the reefs. Depth and conditions not recorded.

Remarks.—These examples appear to me to accord with the description given by Perrier[1] of certain specimens which he has studied and referred to Gray's species. There is, however, no type of *Acanthaster ellisii* in the British Museum; it is therefore extremely doubtful to what form that author applied the name. In the examples under notice the spines are all covered with a thick, closely fitting, fleshy, whitish membrane, which causes them to appear perfectly smooth and glistening in the specimens preserved in spirit, and when the membrane is removed the spine is found to be perfectly smooth. When a spine is dried, however, it appears covered with regularly disposed granules which produce a roughness similar to that assigned as a characteristic feature in *Acanthaster echinites.* The granules, however, are much less pronounced, and are devoid of the central hair-like needle often found in well-preserved examples of *Acanthaster echinites.* The "roughness" of the spines in the Challenger examples is undoubtedly produced by the drying out of granular deposits contained in the investing membranous sheath, and I am inclined to believe from the examination of dried specimens of *Acanthaster echinites* that the same explanation will hold good for that form.

The pedicellariæ in the examples from Zebu and Kandavu appear shorter than in specimens from Mauritius which have been referred to *Acanthaster echinites,* a circumstance also mentioned by Perrier as a character of the form he refers to *Acanthaster ellisii.* The colour is a bright whitish violet.

Notwithstanding the differences noted above, I feel grave doubt as to whether they are of sufficient importance to warrant the specific separation of the form from *Acanthaster echinites;* but with the material at present available I am not in a position to fully discuss the question.

Subfamily Mithrodiinæ, Viguier, 1878.

Genus *Mithrodia*, Gray.

Mithrodia, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 287.
Heresaster, Michelin, Revue Zoologique, 1844, p. 173.

This well-marked form, which has given so much trouble to classifiers, is essentially an inhabitant of tropical seas. Notwithstanding its wide area of geographical distribution, the specific character is maintained with great constancy, and the genus shows a very limited range of morphological plasticity, three species only having been defined.

[1] Révis. Stell. Mus., p. 99 (*Archives de Zool. expér.*, 1875, t. iv. p. 363).

Chorology of the Genus Mithrodia.

α. Geographical distribution:—

Atlantic: One species between the parallels of 15° and 25° S.

Mithrodia victoriæ, off the Victoria Bank, east coast of Brazil.

Indian Ocean: One species between the parallels of 0° and 30° S.

**Mithrodia clavigera*, from Mauritius, and extending into the Eastern Archipelago and Pacific.

Eastern Archipelago: One species between the parallels of 20° N. and 10° S.

**Mithrodia clavigera*, from Java, Flores, and the Moluccas, and extending into the Indian Ocean and Pacific.

Pacific: Two species between the parallels of 30° N. and 30° S.

**Mithrodia clavigera*, from the Fiji Islands, Samoa Islands, Tahiti, and Sandwich Islands, and extending into the Eastern Archipelago and Indian Ocean. *Mithrodia bradleyi*, from the western coast of the American continent, extending from California to Panama.

β. Bathymetrical range: Shallow water to 39 fathoms.

γ. Nature of the Sea-bottom: *Mithrodia clavigera* on coral reefs; *Mithrodia victoriæ* on dead coral; *Mithrodia bradleyi* on rocks.

The species collected by the Challenger is indicated by an asterisk in the above list.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Mithrodia bradleyi . .	Pacific.	Shallow water.	Rocks.
Mithrodia clavigera . .	Indian, Eastern Archipelago, and Pacific.	Shallow water.	Coral reefs.
Mithrodia victoriæ . .	Atlantic.	39	Dead coral.

1. *Mithrodia clavigera* (Lamarck), Perrier.

Asterias clavigera, Lamarck, 1816, Hist. nat. anim. s. vert., t. ii. p. 562.
Mithrodia spinulosa, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 288.
Ophidiaster echinulatus, Müller and Troschel, 1842, System der Asteriden, p. 32.
Heresaster papillosus, Michelin, 1844, Revue Zoologique, p. 173; Mag. de Zool., 1845, p. 19, pl. ix.
Echinaster echinulatus, v. Martens, 1866, Archiv f. Naturgesch., Jahrg. xxxii. Bd. i. p. 59.
Mithrodia echinulata, Lütken, 1871, Videnskab. Medd. natur. Foren. i Kjøbenhavn, p. 266.
Mithrodia clavigera, Perrier, 1875, Révis. Stell. Mus., p. 114 (Archives de Zool. expér., t. iv. p. 378).

Locality.—Kandavu, Fiji Islands. On the reefs.

Subfamily Echinasterinæ, Viguier, 1878.

Genus *Cribrella* (Agassiz), Forbes.

Pentadactylosaster (*pars*), Linck, De Stellis marinis, 1733, p. 34.
Cribrella (*pars*), Agassiz, Mém. Soc. Sci. Nat. Neuchatel, 1835, t. i. p. 191.
Linkia, Forbes, Mem. Wern. Soc., 1839, vol. viii. p. 120.
Henricia, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 184.
Cribella (*pars*), Forbes, Hist. Brit. Starfishes, 1841, p. 100.
Echinaster (*pars*), Müller and Troschel, System der Asteriden, 1842, p. 22.

For a long time the genus *Cribrella* was thought to be represented by a single species only, and to be confined to the northern portion of the Atlantic. Within the last twenty years a number of other species have been discovered, and the genus is found to have a wide area of distribution in the Southern as well as in the Northern temperate and subfrigid zones. In the higher latitudes north of the Equator *Cribrella* is the only representative of the family, but in its approach towards the southern pole it is accompanied by the allied genus *Perknaster*. Its bathymetrical range is greater than that of any other genus of Echinasteridæ, it being the only representative of the family in the Abyssal zone.

Chorology of the Genus Cribrella.

a. *Geographical distribution* :—

Atlantic: Seven species between the parallels of 81° N. and 60° S.

**Cribrella oculata*, off the Scandinavian and British coasts, off Greenland, Labrador, the United States of North America, Spitzbergen, Nova Zembla, in the White Sea, and off the northern coast of Asia (Brandt). *Cribrella antillarum* and *Cribrella sexradiata*, off Barbados, the former also off Guadeloupe, Martinique, and St. Lucia, and the latter off the southern point of Florida. In the extreme South Atlantic: **Cribrella ornata*, from the Cape of Good Hope, and extending into the Pacific. **Cribrella simplex*, off the Tristan da Cunha group, and extending into the Southern Ocean. **Cribrella obesa*, off the Falkland Islands, and also found in the Strait of Magellan on the Pacific side. *Cribrella pagenstecheri*, from South Georgia.

Southern Ocean: Two species between the parallels of 45° and 55° S.

**Cribrella præstans*, from between Marion Island and Kerguelen Island. **Cribrella simplex*, off Prince Edward's Island and Marion Island, and between Marion Island and Kerguelen Island, and extending into the Atlantic. **Cribrella simplex*, var. *granulosa*, from Kerguelen Island.

Pacific: Seven species between the parallels of 55° N. and 55° S.

**Cribrella ornata*, off New Zealand and Campbell Island, and extending to the Cape of Good Hope. **Cribrella compacta*, off New Zealand. **Cribrella sufflata*, north of the Kermadec Islands. *Cribrella densispina* from the Corean Strait, off the west coast of Niphon. *Cribrella læviuscula* from Puget Sound and off the coast of Oregon. *Cribrella minuta*, off the coast of Ecuador. **Cribrella obesa*, off the entrance to Smyth Channel in the Strait of Magellan, and extending to the Falkland Islands.

β. *Bathymetrical range:* Shallow water to 1350 fathoms.

Greatest range of one species: *Cribrella oculata*, shallow water to 1350 fathoms.

γ. *Nature of the Sea-bottom: Cribrella oculata* is found on hard ground, on clay (sandy, Blue, and Biloculina), and Blue mud; *Cribrella antillarum* on hard ground, fine sand, and mud; *Cribrella sexradiata* on broken shells and corals; *Cribrella obesa* on sand, gravel, and Blue mud; *Cribrella præstans* and *Cribrella simplex* on hard ground (gravel, shells), the latter also on Volcanic sand. *Cribrella simplex*, var. *granulosa*, and *Cribrella sufflata*, on Volcanic mud.

The species collected by the Challenger Expedition are indicated by an asterisk in the foregoing list.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Cribrella antillarum	Atlantic.	127 to 734	Hard ground, fine sand and mud.
Cribrella compacta	Pacific.	275	Globigerina ooze.
Cribrella densispina	Pacific.	40	...
Cribrella læviuscula	Pacific.	...	...
Cribrella minuta	Pacific.	...	...
Cribrella obesa	Atlantic and Pacific.	12 to 245	Sand, gravel; Blue mud.
Cribrella oculata	Atlantic and Arctic.	Shallow water to 1350	Clay (sandy, Blue, and Biloculina); Hard ground; Blue mud.
Cribrella oculata, var. *abyssicola*	Atlantic.	516 to 555	...
Cribrella ornata	Atlantic and Pacific.	Shallow water to 20	...
Cribrella pagenstecheri	Atlantic.	(?) less than 14	...
Cribrella præstans	Southern.	210	Hard ground (gravel, shells).
Cribrella sexradiata	Atlantic.	101 to 321 [1]	Broken shells and corals.
Cribrella simplex	Atlantic and Southern.	50 to 310	Hard ground (gravel, shells); Volcanic sand.
Cribrella simplex, var. *granulosa*	Southern.	10 to 50	Volcanic mud.
Cribrella sufflata	Pacific.	520	Volcanic mud.

[1] In the list of stations of the "Blake" Expedition given by Perrier (*Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi. pp. 173, 180), the depths are given as 120 and 321 fathoms; on p. 209 (*op. cit.*) the same two stations are given as 150 and 101 fathoms.

1. *Cribrella oculata* (Linck), Forbes.

Pentadactylosaster oculatus, Linck, 1733, De Stellis marinis, p. 35, tab. xxxvi. No. 62.
Asterias sanguinolenta, O. F. Müller, 1776, Zool. Dan. Prodr., p. 234, No. 2836.
Asterias pertusa, O. F. Müller, 1776, Zool. Dan. Prodr., p. 235, No. 2839.
Asterias oculata, Pennant, 1777, British Zoology, vol. iv. p. 61, pl. xxx. fig. 56.
Asterias spongiosa, Fabricius, 1780, Fauna Grœnlandica, p. 368, No. 363.
Asterias seposita, Retzius, 1783, K. Svensk. Vet.-Akad. Nya Handl., År. 1783, t. iv. p. 237; Dissert. sist. spec. cog. Asteriarum, 1805, p. 21.
Linkia oculata, Forbes, 1839, Mem. Wern. Soc., vol. viii. p. 120.
Henricia oculata, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 184.
Cribella oculata, Forbes, 1841, Hist. Brit. Starfishes, p. 100.
Echinaster oculatus, Müller and Troschel, 1842, System der Asteriden, pp. 24, 127.
Echinaster Eschrichtii, Müller and Troschel, 1842, System der Asteriden, p. 25.
Echinaster sanguinolentus, Sars, 1844, Archiv f. Naturgesch., Jahrg. x., Bd. i. p. 169.
Echinaster Sarsii, Müller and Troschel, 1844, Archiv f. Naturgesch., Jahrg. x., Bd. i. p. 178.
Linckia pertusa, Stimpson, 1853, Invert. Grand Manan, p. 14.
Cribrella sanguinolenta, Lütken, 1857, Videnskab. Medd. naturh. Foren. i Kjøbenhavn, p. 31.
Cribella Eschrichtii, Dujardin and Hupé, 1862, Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 349.
Cribrella oculata, Perrier, 1875, Révis. Stell. Mus., p. 109 (Archives de Zool. expér., t. iv. p. 373).
Cribrella Sarsii, Perrier, 1878, Nouv. Archives Mus. Hist. Nat., 2e Série, t. i. p. 77.

Localities.—Station 46. Off the coast of North America, east of New Jersey. May 6, 1873. Lat. 40° 17′ 0″ N., long. 66° 48′ 0″ W. Depth 1350 fathoms. Blue mud. Bottom temperature 37°·2 Fahr.; surface temperature 40°·0 Fahr.

Station 48. South-west of Halifax, Nova Scotia. May 8, 1873. Lat. 43° 4′ 0″ N.; long. 64° 5′ 0″ W. Depth 51 fathoms. Rock. Surface temperature 38°·0 Fahr.

Station 49. South of Halifax, Nova Scotia. May 20, 1873. Lat. 43° 3′ 0″ N., long. 63° 39′ 0″ W. Depth 85 fathoms. Gravel, stones. Bottom temperature 35°·0 Fahr.; surface temperature 40°·5 Fahr.

"Porcupine" Expedition:

Station 51. In the Faeröe Channel. Lat. 60° 6′ 0″ N., long. 8° 14′ 0″ W. Depth 440 fathoms. Bottom temperature 5°·5 C.; surface temperature 10°·9 C.

Station 52. In the Faeröe Channel. Lat. 60° 25′ 0″ N., long. 8° 10′ 0″ W. Depth 384 fathoms. Bottom temperature −0°·8 C.; surface temperature 11°·2 C.

Station 54. In the Faeröe Channel. Lat. 59° 56′ 0″ N., long. 6° 27′ 0″ W. Depth 363 fathoms. Bottom temperature −0°·3 C.; surface temperature 11°·4 C.

Station 62. In the Faeröe Channel. Lat. 61° 59′ 0″ N., long. 4° 38′ 0″ W. Depth 125 fathoms. Bottom temperature 7°·0 C.; surface temperature 9°·8 C.

Station 65. North-east of the Shetland Islands. Lat. 61° 10′ 0″ N., long. 2° 21′ 0″ W. Depth 345 fathoms. Bottom temperature −1°·1 C.; surface temperature 11°·1 C.

Station 74. East of the Shetland Islands. Lat. 60° 39′ 0″ N., long. 3° 9′ 0″ W. Depth 203 fathoms. Bottom temperature 8°·7 C.; surface temperature 11°·4 C.

Station 90. In the Faeröe Channel. Lat. 59° 41′ 0″ N., long. 7° 34′ 0″ W. Depth 458 fathoms. Bottom temperature 7°·3 C.; surface temperature 11°·7 C.

"Knight Errant" Expedition:

Station 3. Off the Island of North Rona. August 3 and 4, 1880. Lat. 59° 12′ 0″ N., long. 5° 57′ 0″ W. Depth 53 fathoms.

"Triton" Expedition:

Station 1. In the Faeröe Channel. August 4, 1882. Lat. 59° 51′ 30″ N., long. 6° 21′ 0″ W. Depth 240 fathoms. Bottom temperature 47°·0 Fahr.

Station 10.[1] In the Faeröe Channel. August 24, 1882. Lat. 59° 40′ 0″ N., long. 7° 21′ 0″ W. Depth 516 fathoms. Bottom temperature 46°·0 Fahr.

Station 11.[1] In the Faeröe Channel. August 28, 1882. Lat. 59° 29′ 0″ N., long. 7° 13′ 0″ W. Depth 555 fathoms. Bottom temperature 45°·5 Fahr.

2. *Cribrella ornata*, Perrier.

Echinaster (*Cribella*) *ornatus*, Perrier, 1869, Ann. Sci. Nat., 5e Série, t. xii. p. 251.
Cribrella ornata, Perrier, 1875, Révis. Stell. Mus., p. 112 (Archives de Zool. expér., t. iv. p. 376).

Locality.—Simon's Bay, Cape of Good Hope. Depth, shallow water to 20 fathoms.

3. *Cribrella compacta*, n. sp. (Pl. XCVI. figs. 1 and 2; Pl. XCVIII. figs. 3 and 4).

Rays five. R = 15·5 mm.; $r = 3$ mm. $R > 5\,r$. Breadth of a ray at the base, 3 mm.

Rays elongate, delicate, subrigid, tapering from the base to the extremity, which is obtusely pointed. Disk slightly conoid, with faint depressions or sulci along the median interradial lines. Interbrachial arcs distinctly angular.

The abactinal and marginal plates are large in relation to the size of the starfish, and bear compact groups of numerous, uniform, delicate, microscopic spinelets, with denticulate tips. The interspaces or meshes between the plates are smaller than the plates, but are distinctly defined and occupied by a single papula.

Two contingent longitudinal series of plates may be more or less clearly discerned external to the adambulacral plates, the lower one being most distinct; these are probably the representatives of the supero-marginal and infero-marginal plates. These plates are larger than the abactinal plates but are covered with exactly similar spinelets.

The adambulacral plates are very little broader than long, and their armature consists of a compact group of short uniform spinelets, two at the furrow margin, which are placed obliquely so that one is most prominent, being larger than the rest. Frequently a third small spinelet is present on the other side of the foremost spinelet, making a triangular set on the furrow margin. The spinelets on the surface of the plate do not show any definite arrangement, but they may be resolved more or less indistinctly into three or four transverse series. There is a single minute spinelet at the apex of the plate, which is placed very high in the furrow.

[1] The examples from these Stations are a deep-sea variety, which I proposed to call var. *cylindrella* (*Trans. Roy. Soc. Edin.*, vol. xxxii. p. 160, pl. xxvi. fig. 8). Canon Norman has since informed me that he thinks this name will be synonymous with his var. *abyssicola*.

The madreporiform body is rather large but indistinctly defined, and its surface is marked with a few coarse, deep, irregular furrows. It is situated at the summit of one of the sloping median interradial depressions above described.

Colour in alcohol an ashy grey.

Locality.—Station 166. Off the west coast of New Zealand. June 23, 1874. Lat. 38° 50′ 0″ S., long. 169° 20′ 0″ E. Depth 275 fathoms. Globigerina ooze. Bottom temperature 50°·8 Fahr.; surface temperature 58°·5 Fahr.

Remarks.—Although the example described is a small and probably not fully grown specimen, its characters appear to be sufficiently well marked to justify its being regarded as a distinct species. It is characterised by the delicate form, by the large plates with the compact groups of numerous spinelets, by the small but well-defined papular areas, by the distinct series of marginal plates, and by the character of the armature of the adambulacral plates. In these points *Cribrella compacta* is readily distinguished from *Cribrella ornata*.

4. *Cribrella obesa*, n. sp. (Pl. XCVI. figs. 3 and 4; Pl. XCVIII. figs. 5 and 6).

Rays five. R = 70 mm.; r = 13 mm. R>5 r. Breadth of a ray near the base, 15 mm.

Rays rather short, cylindrical, and with a short and swollen appearance, the shortness being emphasised by the recurved tips, and the swollen character by the presence of a deep and constricted sulcus in the median interradial lines, which gives the appearance of a small disk with very tumid rays closely pressed together. This, however, is in a great measure deceptive. The rays taper from the base to the extremity, which is not attenuate.

The plates of the abactinal surface are small and their arrangement forms an open network. The plates are beset with small, low, robust, rounded papilliform spinelets, of which two short lineal series are usually present in each group, two or three of these groups and plates going to form the side of a mesh. Within the larger meshes there may be one, two, or more small plates, which seldom bear more than one of the small papilliform spinelets or granules, and single isolated papulæ are present. On the margin of the abactinal area, and on the upper part of the lateral wall, the spinelets become more delicate and tapering.

Rather low down on the lateral wall of the ray is a distinct narrow longitudinal line traversing the whole length, and composed of elongate, horizontally disposed plates, which I consider to be the representatives of a series of narrow supero-marginal plates. Immediately below this series is a series of small, vertically disposed, widely spaced plates, succeeded by another series of much larger plates, also vertically disposed, which I take to be the representatives of the infero-marginal plates. Between these and the adambulacral plates at the base of the ray are two or three longitudinal series of actinal intermediate plates, but these do not extend far along the ray, and

the series next to the adambulacral plates, which is the longest, only extends about half way along the ray. All these plates intervening between the series that I have called the supero-marginal series and the adambulacral plates are remarkable for the manner in which the plates of the several series form vertical or transverse series; these pass from the adambulacral plates to the supero-marginal plates, and continuations of the same lines are also seen to extend for a short distance above the supero-marginal series, the abactinal plates there having a tendency to fall into the same arrangement. All the plates above mentioned are thickly beset with compact groups of spinelets similar to those on the abactinal plates, and large papulæ occur in the interspaces.

The armature of the adambulacral plates consists of a transverse series of about three comparatively large, robust, slightly tapering spinelets, followed by one or two pairs of much smaller spinelets at the outer end of the plate. Occasionally there may be four or five spinelets in the transverse series, and occasionally one or more may be out of the line, thus appearing to form an oblique pair with its neighbour in the series. There is a single isolated small spinelet at the apex of the plate placed very high up in the furrow.

The madreporiform body is large, circular, and slightly raised. It is situated at the summit of one of the interradial sulci. Its surface is marked with rather coarse striations which radiate from the centre to the periphery, and the dissepiments are studded with comparatively large, low, rounded granules.

Colour in alcohol, a slightly brownish ashy grey.

Localities.—Station 315. Port William, Falkland Islands. January 26, 1876. Lat. 51° 40′ 0″ S., long. 57° 50′ 0″ W. Depth 12 fathoms. Sand, gravel. Surface temperature 50°·0 Fahr.

Station 311. Off the entrance to Smyth Channel. January 11, 1876. Lat. 52° 45′ 30″ S., long. 73° 46′ 0″ W. Depth 245 fathoms. Blue mud. Bottom temperature 46°·0 Fahr.; surface temperature 50°·0 Fahr.

Remarks.—In the character of its spinulation this species resembles to a certain extent *Cribrella ornata*, but differs greatly from it in the widely open network formed by the abactinal plates. The general habit of the two forms is altogether different; and the definite transverse or vertical series of plates on the lateral and actinal regions of the ray, and the character of the adambulacral armature of *Cribrella obesa*, furnish strikingly conspicuous characters by which the species may be distinguished.

The examples from the Strait of Magellan are somewhat less robust in the ray than the type form.

5. *Cribrella præstans*, n. sp. (Pl. XCVI. fig. 7; Pl. XCVIII. figs. 7 and 8).

Rays five. R = 88 to 90 mm; $r = 14$ mm. $R > 6\,r$. Breadth of a ray at the base, about 18 mm. Breadth about midway between the disk and the extremity, 10 mm.

Rays elongate, cylindrical, but subdepressed near the base and over the disk, which is

capable of some inflation, tapering gradually from the base to the extremity, the outer half of the ray being narrow and attenuate, and the tips recurved in the specimen under notice. The disk is comparatively large for the genus.

The plates of the abactinal surface are small and form a compact network. Amongst them are larger plates, which are slightly more prominent and bevelled into an indistinct ridge; and these larger plates are so arranged as to form a continuous but still more or less indistinct, large and widely-open network, in the large meshes of which are placed a number of the smaller plates with single isolated papulæ interspersed. Upon the larger plates are borne small compact groups of short microscopic spinelets, the groups being distinctly spaced; on the smaller plates within the meshes there are seldom more than two or three similar spinelets, and their posture is divergent rather than tending to form a compact group. All the spinelets are covered with skin, and they are undistinguishable without the aid of a magnifying-glass.

An indistinct line of small narrow plates, forming a thin longitudinal series (the posture of the plates being horizontal), may be discerned on the upper part of the lateral wall of the ray, the representatives, perhaps, of a supero-marginal series. About midway between this series and the adambulacral plates is a second longitudinal series of larger plates (the posture of the plates being vertical), probably the representatives of an infero-marginal series. The plates of both these series bear groups of spinelets similar to those above described. The intermediate space between the two series, which diminishes in breadth as it extends along the ray, is occupied by small plates similar to those on the abactinal surface, and these have a tendency to form vertical and equally spaced lines between the two longitudinal series, with irregular plates and papulæ in the interspaces. Much irregularity, however, occurs, and the arrangement indicated can only be made out here and there. The space between the lower longitudinal series (the infero-marginal plates ?) and the adambulacral plates is occupied by larger plates, arranged in more or less regular longitudinal lines parallel to the furrow. These plates, which are probably actinal intermediate plates, are much more uniform and bear more definite groups of rather longer spinelets than those on the lateral and abactinal areas. About two series of these intermediate plates may be counted midway on the ray, and the number increases gradually towards the disk. Papulæ are present between the intermediate plates.

The armature of the adambulacral plates consists of a single small skin-covered spinelet standing at the apex of the plate and placed high in the furrow, which is followed by about two or three pairs of larger spinelets and a small compact group of irregularly placed spinelets, the whole forming a transversely placed group, the spinelets of which decrease in size as they recede from the furrow.

The madreporiform body, which is rather large and circular, is situated rather nearer the centre than midway between that point and the margin. Its surface is grooved with deep striæ, radiating from the centre to the margin, and the intervening dissepiments

are closely studded with conical spinelets, which give the surface a very echinulate appearance, and almost mask its presence.

Colour in alcohol, a dirty light brownish grey.

Locality.—Station 148. Off the Crozet Islands. January 3, 1874. Lat. 46° 47′ 0″ S., long. 51° 37′ 0″ E. Depth 210 fathoms. Hard ground, gravel, shells. Surface temperature 41°·0 Fahr.

Remarks.—This species is distinguished from all the species with which I am acquainted by the peculiar secondary network on the abactinal surface, the meshes of which are filled up with smaller plates. The extremely small microscopic spines borne on the abactinal plates, and the subregular well-defined series of actinal intermediate plates, also furnish marks by which the species may be recognised.

6. *Cribrella simplex*, n. sp. (Pl. XCVII. figs. 5 and 6 ; Pl. XCVIII. figs. 9 and 10).

Rays five. R = 27 mm. ; r = 6 mm. R = 4·5 r. Breadth of a ray at the base, 6·25 mm.

Rays elongate, rounded, perfectly cylindrical, tapering gradually but slightly from the base to the extremity, which is obtuse. Disk small, with more or less distinct depressions or sulci in the median interradial lines abactinally. Deeper and more conspicuous depressions are present on the actinal surface. Interbrachial arcs angular.

The plates of the abactinal surface, which are small and narrow, form a clearly defined open network of delicate character. The plates are bevelled into a more or less distinct ridge, upon which are borne, at wide intervals apart, single isolated hemispherical or slightly conoid granules, which are quite invisible without the aid of a magnifying-glass. The meshes are relatively large and are occupied by one or occasionally two papulæ.

On the lateral wall of the ray an indistinct longitudinal series of small plates, which represent a supero-marginal series, may be discerned ; and below these a second and more conspicuous longitudinal series of larger plates, which represent the infero-marginals, is present. These two series are separated on the inner half of the ray by a series of small, vertically disposed, intermediate plates between which are large papulæ ; and on the inner half of the ray the infero-marginal series is separated from the adambulacral plates by actinal intermediate plates, of which two or even three series may be present at the base of the ray, but the upper series extends a very short distance, and that next the adambulacral plates extends very little further than half way along the ray. The spinulation of the plates above described, which intervene between the abactinal and adambulacral plates, is remarkable, from the fact that it shows a tendency to form vertical or transverse single lines of papilliform granules. In some examples the vertically disposed series of granules on the infero-marginal plates may be doubled.

The armature of the adambulacral plates consists of a single transverse series of three

or four robust, short, slightly tapering spinelets; the outermost is much smaller than the others, and sometimes an additional one is present there. On some of the plates near the mouth one of the spines in the transverse series may be out of the line, which produces the appearance of an oblique pair. At the apex of the plate is a single minute spinelet placed very high up in the furrow.

The madreporiform body, which is well defined, circular, and slightly raised, is situated rather nearer the centre than midway between that point and the margin. Its surface is marked with few striations, which are coarse and radiate from the centre to the periphery. There are a few isolated spinelets or granules on the dissepiments.

Colour in alcohol, a bleached yellowish white.

Localities.—Off Inaccessible Island, Tristan da Cunha group. Depth 90 fathoms.

Off Nightingale Island, Tristan da Cunha group. Depth 100 to 150 fathoms.

Station 148. Off the Crozet Islands. January 3, 1874. Lat. 46° 47′ 0″ S., long. 51° 37′ 0″ E. Depth 210 fathoms. Hard ground, gravel, shells. Surface temperature 41°·0 Fahr.

Station 145A. Off Prince Edward Island. December 27, 1873. Lat. 46° 41′ 0″ S., long. 38° 10′ 0″ E. Depth 310 fathoms. Volcanic sand. Surface temperature 41°·5 Fahr.

Off Marion Island. Depth 50 fathoms.

Remarks.—This species is characterised by the extreme simplicity of the spinulation of the abactinal plates, and of the armature of the adambulacral plates, and by the lineal disposition of the granules on the lateral wall of the rays.

6*a*. *Cribrella simplex*, var. *granulosa*, nov.

There is a small *Cribrella* from the neighbourhood of Kerguelen which I consider to be a variety of this species, although at first sight it differs greatly in superficial character. This difference in appearance arises from the fact that the granules on the abactinal plates are larger and more numerous, and that the lineal disposition of granules on the lateral wall of the ray is more or less masked. The variation may be traced through various stages of divergence from the type form, and in some the only differences noticeable are the larger size and somewhat greater number of the granules. On these grounds I do not consider that there is sufficient justification for regarding the Kerguelen form as specifically distinct from *Cribrella simplex*. The mimetic resemblance of this variety to *Pedicellaster scaber* from the same region is highly remarkable.

Colour in alcohol, a brownish ashy grey.

Localities.—Royal Sound, Kerguelen Island. Depth 28 fathoms.

Off Kerguelen. Position not recorded. Depth 10 to 50 fathoms.

7. *Cribrella sufflata*, n. sp. (Pl. XCVI. figs. 5 and 6; Pl. XCVIII. figs. 1 and 2).

Rays five. R = 80 mm.; r = 12 mm. R < 7 r. Breadth of a ray at the inflation near the base, 13 to 14 mm.; breadth of the same ray about midway between the disk and the extremity, 7 mm.

Rays elongate, rounded, and perfectly cylindrical, abruptly inflated near the base, the inflation tapering off more gradually outwardly, the outer half of the ray being narrow and attenuate. The tip is recurved in the specimen described. The disk is very small.

The plates of the abactinal surface are small, and form a distinct but rather close network. They are narrow and bevelled into an indistinct ridge, upon which are borne extremely small, widely spaced, conical granules; at intervals two or three are near together, and form an incipient group. Upon the disk, where the granules are slightly larger and the network closer, grouping is more apparent. These granules or incipient spinelets are so small that they only produce a slight roughness to the touch when the specimen is handled, and are invisible without the help of a magnifying-glass. There is seldom more than one papula in each interspace.

Along the lateral wall of the ray is a distinct narrow longitudinal line which traverses the whole length; this is composed of more compact and crowded groups of granules borne on what are probably the representatives of a series of small narrow marginal plates. A similar longitudinal line, in which the granules become more spiniform, may be traced immediately external to the adambulacral plates, at least on the inner half of the ray. The interspace between these two series gradually diminishes as it proceeds along the ray, and may be roughly divided into two longitudinal areas, the lower of which is occupied by rather large plates (in comparison with those hitherto mentioned); these are higher than long, and bear more or less definite vertically disposed groups of papilliform granules, separated by papulæ. The upper part of the area bears small irregular groups, with papulæ interspersed.

The armature of the adambulacral plates consists of about four pairs of spinelets (the spinelets of each pair placed slightly obliquely), followed on the outer part of the plate by one or two rows of two or three smaller spinelets, the whole forming a compact transversely disposed group. The spinelets decrease in size as they recede from the furrow; the innermost pairs show some tendency to a subprismatic form, and have a rather thick membranous sac. There is a single isolated smaller spinelet high up in the furrow.

The madreporiform body is small, irregular, and indistinct. Its surface is marked with few striations, which are not convoluted, and the intervening dissepiments are studded with uniform, papilliform, rounded granules.

The anal aperture, which is large and distinct, is distinctly excentric in position.

Colour in alcohol, a warmish shade of light brown, but the greater part is bleached into an ashy grey.

Locality.—Station 170. North of the Kermadec Islands. July 14, 1874. Lat.

29° 55′ 0″ S., long. 178° 14′ 0″ W. Depth 520 fathoms. Volcanic mud. Bottom temperature 43°·0 Fahr.; surface temperature 65°·0 Fahr.

Remarks.—Whether the inflation at the base of the ray is the normal form, or is due to this specimen being a female and in a gravid condition, I am unable to say without mutilating the single example at my disposal. The species may be recognised by its general form, by the character of the spinulation of the abactinal plates, and by the structure of the lateral and actinal skeleton.

Genus *Perknaster*, n. gen.

Disk large and more or less inflated. Rays cylindrical and tapering.

Abactinal and lateral surfaces up to the adambulacral plates covered with small undistinguishable plates, which bear groups of short, equal spinelets, covered with skin, dispersed in tufts or paxilliform groups, more or less compactly placed.

Armature of the adambulacral plates disposed in one or two transverse series; the innermost spinelet usually large and thickly skin-covered. No small inner spinelet placed high up in the furrow as in *Cribrella*.

Madreporiform body distinct, situated about midway between the centre of the disk and the margin; surface marked with fine, convoluted striations.

Anal aperture subcentral and inconspicuous.

Ambulacral tube-feet in regular biserial arrangement, and having large fleshy terminal disks.

No pedicellariæ of any kind present.

Remarks.—This genus, though allied to *Cribrella*, is at once characterised by the large development of the disk, by the compact structure of the abactinal and lateral skeleton, by the homogeneity of the marginal plates, and by the character of the armature of the adambulacral plates. The general facies of the forms I have included in the genus is very different from that of *Cribrella*, or any other type.

Chorology of the Genus Perknaster.

α. *Geographical distribution:*—

SOUTHERN OCEAN: Two species between the parallels of 45° and 55° S.
Perknaster fuscus and *Perknaster densus*, from Kerguelen Island, the former also from Heard Island.

β. *Bathymetrical range:* 25 fathoms to 127 fathoms.

γ. *Nature of the Sea-bottom:* Volcanic mud.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Perknaster densus . .	Southern.	127	Volcanic mud.
Perknaster fuscus . .	Southern.	25 to 75	Volcanic mud.

1. *Perknaster fuscus*, n. sp. (Pl. XCVII. figs. 3 and 4).

Rays five. R = 45 mm.; r = 14 mm. R > 3 r. Breadth of a ray near the base, 14 mm.; breadth about midway between the disk and the extremity, 5 mm.

Disk large and inflated. Rays short, rounded, broad at the base, then rapidly decreasing in breadth and tapering slightly to the extremity, which is thick and obtuse. Interbrachial arcs wide and open, rounded, or with a faint trace of angularity at the summit. On the disk, in the median interradial lines, are more or less sharply defined depressions or sulci extending from the margin midway to the centre. The actinal surface round the mouth is slightly depressed.

The whole abactinal and lateral surfaces extending up to the adambulacral plates are covered with undistinguishable plates which bear small tufts or groups of short, robust, equal spinelets, thickly covered with skin and not particularly compactly placed; the whole forming a papillate and more or less irregularly grouped surface. No order of arrangement is discernible and there is no approach to a reticulate character. Between the plates numerous papulæ are interspersed.

On the interradial areas of the actinal surface a certain amount of regularity may be traced, the plates there falling into more or less distinct longitudinal and transverse series; there are not more than two or three spinelets borne on these plates, and the groups consequently have a rather more distinct and isolated appearance. Indistinct traces of what are perhaps the representatives of a series of infero-marginal plates may be made out at the junction of the actinal interradial and lateral areas.

The armature of the adambulacral plates consists of a transverse series of three robust and very thickly skin-covered spinelets, followed on the outer part of the plate by a pair of much smaller spinelets. The innermost or furrow spine is longer and larger than the others, and with its membranous investment nearly as thick as the length of the plate. There is no small inner spinelet within the furrow.

The madreporiform body, which is large and distinctly defined, is situated about midway between the centre of the disk and the margin, or may be rather nearer the former. Its surface is grooved with numerous fine and convoluted striations and has a strikingly coral-like appearance.

Colour in alcohol, a dark purplish brown on the abactinal surface. The numerous spinelet-tips are nearly white. The actinal surface is much lighter than the abactinal.

Localities.—Station 149B. Off Royal Sound, Kerguelen Island. January 17, 1874. Depth 25 fathoms. Volcanic mud. Surface temperature 40°·5 Fahr.

Station 151. Off Heard Island. February 7, 1874. Lat. 52° 59′ 30″ S., long. 73° 33′ 30″ E. Depth 75 fathoms. Volcanic mud. Surface temperature 36°·2 Fahr.

Remarks.—This species may be distinguished from *Perknaster densus* by the general form, by the colour, by the character of the spinulation, and by the armature of the adambulacral plates. In the last-mentioned particular *Perknaster fuscus* approaches the character of some of the Southern species of *Cribrella*, but the present form could not be mistaken for any of these.

The example dredged off Heard Island is somewhat longer in the rays than those from Kerguelen.

2. *Perknaster densus*, n. sp. (Pl. XCVII. figs. 1 and 2; Pl. XCVIII. figs. 11 and 12).

Rays five. R = 51 mm.; r = 16 mm. R > 3 r. Breadth of a ray at the base, about 18 mm.; breadth about midway between the disk and the extremity, 7·5 mm.

Disk large and inflated. Rays subcylindrical, broad at the base, and tapering gradually up to the extremity, which is obtusely pointed. Interbrachial arcs distinctly angular. Slight depressions feebly defined are present in the median interradial lines on the abactinal surface of the disk. The actinal surface of the disk is concave.

The whole abactinal and lateral surfaces, extending up to the adambulacral plates, are covered with small plates which bear small compact groups of short, obtusely rounded, equal spinelets; the whole resembling closely crowded paxillæ. Between the plates papulæ are interspersed, but are rarely visible superficially in consequence of the crowding of the spinulation. No order of arrangement whatever is discernible in the plates either on the abactinal or actinal areas, and no traces of the representatives of marginal plates can be detected.

The armature of the adambulacral plates consists of about three pairs of obliquely placed spinelets, the whole forming a transverse double series of spinelets. The innermost pair are larger than the others, and thickly skin-covered, which gives them a robust and often a subprismatic appearance. The outer spinelets are shorter and more cylindrical, and merge into the general spinulation of the actinal surface. The obliquity of the position of the pairs causes one of the spinelets of the innermost pair to be more prominent into the furrow than its companion. No small inner spinelet is present high up in the furrow, as in *Cribrella*.

The madreporiform body, which is rather large, is situated about midway between the centre of the disk and the margin, and its surface is marked with fine convoluted striations.

Colour in alcohol, a dirty light purplish brown or ashy grey.

Locality.—Station 149H. Off Cumberland Bay, Kerguelen Island. January 29, 1874. Lat. 48° 45′ 0″ S., long. 69° 14′ 0″ E. Depth 127 fathoms. Volcanic mud. Surface temperature 39°·8 Fahr.

Remarks.—*Perknaster densus* is readily distinguished from its ally *Perknaster fuscus* by the general form, by the densely crowded spinulation, and by the character of the armature of the adambulacral plates.

Genus *Echinaster*, Müller and Troschel.

Echinaster (Llhuyd), Prælectio de Stellis marinis Oceani Britannici, 1703 (*et* Append. Linck, De Stellis marinis), p. 80 (name).
Stellonia (*pars*), Nardo, De Asteriis, Oken's Isis, 1834, p. 716.
Echinaster, Müller and Troschel, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, 1840 (April), p. 102.
Othilia, Gray, Ann. and Mag. Nat. Hist., 1840 (December), vol. vi. p. 281.
Rhopia, Gray, Ann. and Mag. Nat. Hist., 1840 (December), vol. vi. p. 282.

This well-known genus inhabits the tropical and warmer temperate seas of the globe, where several of the species are common forms and have been long recognised.

Chorology of the Genus Echinaster.

a. Geographical distribution :—

Atlantic : Eight species between the parallels of 75° N. and 30° S.
Echinaster scrobiculatus, off the coast of Finmark. *Echinaster sepositus*, from the Mediterranean, and off the coast of Brittany and Gascony. *Echinaster brasiliensis* and **Echinaster spinosus*, off the coast of Brazil, the latter extending northward to Virginia. *Echinaster sentus* and *Echinaster spinulosus*, off the coast of Florida. *Echinaster serpentarius*, from Vera Cruz. *Echinaster modestus*, from the West Indian area, off Montserrat, St. Vincent, and north of Havana.

Indian Ocean : Three species between the parallels of 30° N. and 30° S.
Echinaster fallax, from the Red Sea, Zanzibar, and Querimba Island, and extending into the Eastern Archipelago and Pacific. *Echinaster gracilis*, from Madagascar. *Echinaster vestitus*, from Mayotte Island.

Southern Ocean : One species between the parallels of 45° and 55° S.
**Echinaster spinulifer*, from Kerguelen Island.

Eastern Archipelago : One species between the parallels of 20° N. and 20° S.
Echinaster fallax, from Timor and the Philippine Islands, and extending into the Indian Ocean and into the Pacific.

Pacific: Four species between the parallels of 40° N. and 45° S.

Echinaster fallax, from New Zealand (*fide* Perrier), and extending into the Eastern Archipelago and Indian Ocean. **Echinaster eridanella*, off the Admiralty Islands, New Caledonia, and New Ireland. *Echinaster tenuispinus*, off the coast of California. *Echinaster cribella*, off the coast of Chili.

β. *Bathymetrical range:* Probably all the species are confined to the Littoral zone, with the exception of *Echinaster modestus*, which is stated by Perrier[1] to occur in 309 fathoms.

γ. *Nature of the Sea-bottom:* *Echinaster spinulifer* is found on Volcanic mud; other species not recorded.

The species collected by the Challenger Expedition are indicated in the foregoing list by an asterisk.

The localities of the following species are unknown, and they have consequently not been included in the lists given above :—

Echinaster crassus, Müller and Troschel.
Echinaster deplanatus, Grube.
Echinaster lacunosus, Grube.
Echinaster rigidus, Grube.

Chorological Synopsis of the Species herein mentioned.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Echinaster eridanella . .	Pacific.	16 to 25	...
Echinaster spinosus . . .	Atlantic.[?]	7 to 20	...
Echinaster spinulifer . .	Southern.	28 to 127	Volcanic mud.

1. *Echinaster spinosus* (Retzius), Müller and Troschel.

Pentadactylosaster spinosus regularis, Linck, 1733, De Stellis marinis, p. 35, tab. iv. No. 7.
Asterias spinosa, Retzius, 1805, Dissert. sist. spec. cog. Asteriarum, p. 18.
Asterias echinophora, Lamarck, 1816, Hist. nat. anim. s. vert., t. ii. p. 560.
Othilia spinosa, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 281.
Echinaster spinosus, Müller and Troschel, 1842, System der Asteriden, p. 22.
Echinaster (*Othilia*) *crassispina*, Verrill, 1871 (1868), Trans. Conn. Acad. Arts and Sci., vol. i. part 2, p. 368, pl. iv. fig. 7.

[1] *Nouv. Archives Mus. Hist. Nat.*, 1884, 2e Série, t. vi. p. 179. The greatest depth of this species is stated (*op. cit.*) on p. 206 to be 123 fathoms; but on p. 179 of the same work an example is recorded from 309 fathoms from a different locality from those cited on p. 206, although it bears the same station number (No. 170) as one of them.

Echinaster crassispinus, Lütken, 1871, Videnskab. Medd. naturh. Foren. i Kjøbenhavn, p. 61.
Echinaster echinophorus, Perrier, 1875, Révis. Stell. Mus., p. 100 (Archives de Zool. expér., t. iv. p. 364).

Locality.—Bahia. Depth 7 to 20 fathoms.

2. *Echinaster eridanella*, Müller and Troschel.

Echinaster eridanella (Valenciennes, M. S.), Müller and Troschel, 1842, System der Asteriden, p. 42.
Echinaster affinis, Perrier, 1869, Ann. Sci. Nat., 5e Série, t. xii. p. 250.

Locality.—Admiralty Islands. Depth 16 to 25 fathoms.

3. *Echinaster spinulifer*, Smith.

Othilia spinulifera, Smith, 1876, Ann. and Mag. Nat. Hist., ser. 4, vol. xvii. p. 107.
Echinaster spinulifer, Smith, 1879, Phil. Trans., Zool. Kerguelen Island, vol. clxviii. p. 274, pl. xvi. fig. 4.

Localities.—Station 149D. Royal Sound, Kerguelen Island. January 20, 1874. Lat. 49° 28′ 0″ S., long. 70° 13′ 0″ E. Depth 28 fathoms. Volcanic mud. Surface temperature 41°·0 Fahr.

Station 149H. Off Cumberland Bay, Kerguelen Island. January 29, 1874. Lat. 48° 45′ 0″ S., long. 69° 14′ 0″ E. Depth 127 fathoms. Volcanic mud. Surface temperature 39°·8 Fahr.

Family Heliasteridæ, Viguier, 1878.

This family possesses a comparatively limited area of distribution, and appears to be confined to the western coast of South America; the type genus being there represented by a number of so-called species which exhibit a remarkable uniformity of facies.

The family contains only the single genus *Heliaster*.

Genus *Heliaster*, Gray.

Heliaster, Gray, Ann. and Mag. Nat. Hist., 1840, vol. vi. p. 179.

This genus, so far as at present known, is limited to the eastern side of the Pacific, and extends along the coast of the American continent from California to Chili, inhabiting shallow water. I greatly doubt whether all the so-called species which have been recognised can be maintained when a sufficient series of examples can be studied side by side, the differences by which they are separated being exceedingly slight.

Chorology of the Genus Heliaster.

a. Geographical distribution:—

Pacific: Five species between the parallels of 30° N. and 40° S.

Heliaster cumingii, from Hood's Island and Chatham Island (Galapagos Archipelago), and probably extending to Peru (*fide*

Verrill). *Heliaster microbrachia*, from California and Mexico, and extending to Panama and the Pearl Islands. *Heliaster multiradiata*, from California, Mexico, the Galapagos Islands, and Sandwich Islands. **Heliaster helianthus*, off the coasts of Ecuador, Peru, and Chili. *Heliaster canopus*, from the Island of Juan Fernandez.

β. *Bathymetrical range:* Shallow water.

γ. *Nature of the Sea-bottom:* Most of the species have been collected on rocks at low water.

The species collected by the Challenger is indicated in the above list by an asterisk.

Chorological Synopsis of the Species herein mentioned.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Heliaster helianthus . .	Pacific.	Shallow water.	Rocks.

1. *Heliaster helianthus* (Lamarck), Dujardin and Hupé.

Asterias helianthus, Lamarck, 1816, Hist. nat. anim. s. vert., t. ii. p. 558.
Stellonia helianthus, Agassiz, 1835, Mém. Soc. Sci. Nat. Neuchatel, t. i. p. 192.
Asterias (*Heliaster*) *helianthus*, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 179.
Asteracanthion helianthus, Müller and Troschel, 1842, System der Asteriden, p. 18.
Heliaster helianthus, Dujardin and Hupé, 1862, Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 344.

Locality.—Valparaiso. Shallow water.

Remarks.—The examples collected at this locality show a great variation in the number and length of the rays, and in the character of the abactinal spinulation. I see no reason, however, for considering that they belong to more than the one species; but the circumstance brings into prominence the question of the validity of the characters by which the species in this genus have been mainly distinguished.

Family Pedicellasteridæ, Perrier, 1884.

The family Pedicellasteridæ was established by Perrier[1] in 1884 for the reception of the genera *Pedicellaster* and *Zoroaster*. In the following year (1885), however, *Zoroaster* was removed by Perrier[2] into the family Stichasteridæ, and *Pedicellaster* was ranked in the family Brisingidæ. The family Pedicellasteridæ was thus by act dispersed, although no mention of the circumstance is made or explanation given. I am unable to agree

[1] *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi., pp. 154, 167, 194.
[2] *Ann. Sci. Nat.* (Zool.), 1885, t. xix., Art. No. 8, p. 15.

either as to the position of *Zoroaster* in the Stichasteridæ or of *Pedicellaster* in the Brisingidæ. The former seems to me to warrant classification in a distinct family, and *Pedicellaster*, on the other hand, differs so widely in character and structural details from *Brisinga* and its allies, that I cannot regard them as belonging to the same family. Although I feel much uncertainty as to whether the characters of *Pedicellaster* are of sufficient value to justify its recognition as the type of an independent family, the structure of the skeleton, the character of the tegumentary appendages, and the character of the water-vascular system present an assemblage of differences which, in my opinion, require recognition; and I therefore prefer, in the present state of knowledge of the anatomy of these little known forms, to retain the family Pedicellasteridæ, rather than relegate *Pedicellaster* to a subdivision of one of the allied families. The family as now recognised comprises the single genus *Pedicellaster*.

Genus *Pedicellaster*, Sars.

Pedicellaster, Sars, Oversigt af Norges Echinodermer, Christiania, 1861, p. 77.

Since the discovery of this genus in the North Atlantic area a number of forms have been referred to it, which indicate a wide range of distribution. Although I am inclined to think that the whole of the species now ranked as *Pedicellaster* may not ultimately be retained in the genus, the occurrence of representative forms in the higher latitudes of the Northern and Southern hemispheres is fully established. As to the relations of the intermediate and doubtful forms, I withhold for the present any expression of opinion, as I have not had an opportunity of examining specimens.

Chorology of the Genus Pedicellaster.

a. Geographical distribution:—

Atlantic: Seven species between the parallels of 82° N. and 60° S.

Pedicellaster typicus, off the Norwegian and Murman coasts, and off Nova Zembla, Jan Mayen, and Beeren Island. *Pedicellaster palæocrystallus*, off Grinnell Land at Discovery Bay and Cape Frazer. *Pedicellaster pourtalesi*, off Grenada and St. Kitts. *Pedicellaster margaritaceus* and *Pedicellaster sexradiatus*, dredged by the "Travailleur," the former at Station 39, the latter at Stations 3 and 5. *Pedicellaster octoradiatus* and *Pedicellaster sarsii*, off the Island of South Georgia.

Southern Ocean: Two species between the parallels of 45° and 55° S.

**Pedicellaster scaber*, off Kerguelen Island. **Pedicellaster hypernotius*, off Marion Island.

β. Bathymetrical range: 14 to 1808 fathoms.

Greatest range of one species: *Pedicellaster typicus*, 50 to 620 fathoms.

Of the other species *Pedicellaster margaritaceus* and *Pedicellaster sexradiatus* only occur in the Abyssal zone. The remainder inhabit the Littoral zone, and are not recorded from greater depths, excepting *Pedicellaster pourtalesi*, which extends into the Continental zone.

γ. Nature of the Sea-bottom: *Pedicellaster typicus* is found on Clay (sometimes sandy) and Stones; *Pedicellaster palæocrystallus* on a hard bottom; *Pedicellaster pourtalesi* on fine sand; *Pedicellaster scaber* on Volcanic mud; and *Pedicellaster hypernotius* on Volcanic sand.

The species collected by the Challenger are indicated in the above list by an asterisk.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Pedicellaster hypernotius . .	Southern.	140	Volcanic sand.
Pedicellaster margaritaceus .	Atlantic.	670	...
Pedicellaster octoradiatus . .	Atlantic.	14	...
Pedicellaster palæocrystallus .	Atlantic.	25 to 80	Hard bottom.
Pedicellaster pourtalesi . .	Atlantic.	127 to 250	Fine sand.
Pedicellaster sarsii . . .	Atlantic.	...	...
Pedicellaster scaber . . .	Southern.	20 to 25	Volcanic mud.
Pedicellaster sexradiatus . .	Atlantic.	1730 to 1808	...
Pedicellaster typicus . . .	Atlantic.	50 to 620	Clay (sometimes sandy); Stones.

1. *Pedicellaster scaber*, Smith.

Pedicellaster scaber, Smith, 1876, Ann. and Mag. Nat. Hist., ser. 4, vol. xvii. p. 107; Phil. Trans., Zool. Kerguelen Island, 1879, vol. clxviii. p. 274, pl. xvi. fig. 3.

Locality.—Station 149D. Royal Sound, Kerguelen Island. January 20, 1874. Lat. 49° 28′ 0″ S., long. 70° 13′ 0″ E. Depth 20 to 25 fathoms. Volcanic mud. Surface temperature 41°·0 Fahr.

Remarks.—This is a well-marked species, and is not merely a variety of *Pedicellaster typicus*, as suggested by Danielssen and Koren.[1]

2. *Pedicellaster hypernotius*, n. sp. (Pl. CV. figs. 5–7).

Rays five. R = 25 mm.; $r = 5$ mm. R = 5 r. Breadth of a ray at the base 5·25 mm.

Rays elongate, narrow, tapering very slightly; probably subcylindrical during life, more or less depressed in their present condition. Disk small, not distinguishable from the base of the rays. Interbrachial arcs acute.

[1] *Nyt Mag. f. Naturvidensk.*, Bd. xxvii. p. 274; Den Norske Nordhavs-Expedition, 1876–1878, Zoologi, xi. Asteroidea, Christiania, 1884, p. 40.

The abactinal surface is beset with small narrow plates which are arranged in longitudinal and transverse lines, forming an open network with regular square meshes. In some places there appear to be indications of cruciform plates at the intercrossing parts, but I am unable to say whether such plates really occur, or the resemblance is only superficial and due to partial anastomosis of the plates at the crossing. Small, isolated, microscopic spinelets with denticulate tips are borne on the abactinal plates, usually one at each decussation, and sometimes one midway on the transverse trabeculæ. The meshes are covered with membrane, which is crowded with rather large, uniform, forcipiform pedicellariæ. These are so numerous that they mask altogether the papulæ and give a general semicrystalline granular appearance to the surface, when examined with a magnifying-glass of low power.

The marginal plates do not appear to be in any way differentiated; and the uniform crowding of pedicellariæ extends up to the adambulacral plates.

The adambulacral plates are very small, and their armature consists of two rather elongate subequal spinelets, placed one behind the other and slightly obliquely. They are covered with membrane, which on the spines near the mouth forms a more or less saccular sheath.

On the inner half of the ray, at the base of the innermost spine, on the margin of the ambulacral furrow, there may be seen here and there a very small pedicellaria, which I believe to be forficiform in type. It is, however, much smaller than the forcipiform pedicellariæ, which are so numerous on the test generally, and appears to be more or less aborted in character.

The madreporiform body, which is very small and difficult to distinguish, is situated near the margin of the disk, and its surface is marked with only two or three simple furrows. The ambulacral tube-feet are arranged in simple biserial series.

Colour in alcohol, a dirty ashy grey.

Locality.—Station 145. Off Marion Island. December 27, 1873. Lat. 46° 43′ 0″ S., long. 38° 4′ 30″ E. Depth 140 fathoms. Volcanic sand. Surface temperature 41°·0 Fahr.

Remarks.—This is a true *Pedicellaster*, and differs in no way from the structural characters of *Pedicellaster typicus*. The presence of forficiform pedicellariæ is, however, an anomaly in the genus, which has been considered to possess only one kind—the forcipiform. The representatives of the forficiform pedicellariæ in *Pedicellaster hypernotius* are so small and have such an aborted character that I do not consider their presence sufficient to justify the removal of the form under description from the genus. In my opinion, they give additional interest to this species as representing either rudiments of organs more typically developed in an ancestral form, or incipient stages towards the higher development of this form of pedicellaria as found in other allied Asterids.

Pedicellaster hypernotius is more nearly related to *Pedicellaster typicus* and *Pedicel-*

laster palæocrystallus[1] than to any other species; it may however be distinguished by its general habit, by the form and character of the pedicellariæ, and by the posture and character of the armature of the adambulacral plates. Neither of the three forms above referred to could possibly be mistaken for *Pedicellaster scaber*.

Family Asteriidæ, Gray, 1840, *emend.*

The investigations of the last decade have resulted in the establishment of more definite morphological limits for this cosmopolitan family than were formerly recognised, and the removal of several genera whose plan of structure is essentially different.

The genera now classed together in the family Asteriidæ constitute a well-defined group, the alliance of which is natural and self-evident. They are enumerated in the following table.

Synopsis of the Genera included in the Family Asteriidæ.

A. Abactinal skeleton well developed.
  a. Abactinal skeleton reticulate.
    a. Abactinal plates bearing definite spines . . . . . *Asterias.*
    b. Abactinal plates bearing large spherical tubercles . . . . *Uniophora.*
  b. Abactinal skeleton composed of broad imbricating plates, covered with thick membrane masking the plates and their appendages . . . . *Calvasterias.*
B. Abactinal skeleton more or less aborted.
  a. Rays five. Form subpentagonal . . . . . *Anasterias.*
  b. Rays numerous and elongate . . . . . *Pycnopodia.*

Genus *Asterias*, Linné.

Asterias (*pars*), Linné, Systema Naturæ, 1766, ed. xii. p. 1098.
Stellonia (*pars*), Nardo, De Asteriis, Oken's Isis, 1834, p. 716.
Uraster (Agassiz), Forbes, Mem. Wern. Soc. 1839, vol. viii. p. 114.
Asteracanthion (*pars*), Müller and Troschel, Monatsb. d. k. preuss. Akad. d. Wiss. Berlin, April 1840, p. 102.
Leptasterias, Verrill, Proc. Boston Soc. Nat. Hist., 1866, vol. x. p. 350.
Coscinasterias, Verrill, Trans. Conn. Acad. Arts and Sci., 1871 (1867), vol. i. part 2, p. 248.
Margaraster, Hutton, Cat. Echin. New Zealand, 1872, p. 4 (non *Margaraster*, Gray).
Marthasterias, Jullien, Bull. Soc. Zool. France, 1878, p. 141.

[1] Doubt has been expressed by Drs. Danielssen and Koren (*Nyt Mag. f. Naturvidensk.*, Bd. xxvii. p. 270; Den Norske Nordhavs-Expedition, 1876–1878, Zoologi, xi. Asteroidea, Christiania, 1884, p. 39) as to the validity of this species, which they consider to be identical with *Pedicellaster typicus*. The arguments drawn from certain points of structure, which they state were insufficiently described by Sars, strongly support that view; nevertheless, whilst acknowledging the cogency of the facts adduced by my learned colleagues and with full respect for their judgment, I venture to retain the species, at least for the present, as, after the examination of further specimens referred to *Pedicellaster typicus*, I am still inclined to believe that the two forms are distinct. I hope, on a future occasion, to be able to compare them side by side and finally settle the question.

This large and widely distributed genus was subjected a few years ago to a critical revision by Professor F. Jeffrey Bell,[1] who carefully investigated the claims of the large number of forms referred to *Asterias* to be ranked as distinct species. All workers at the group owe a debt of gratitude to the author of this admirable and useful memoir. Professor Bell divided the genus into artificial sections, and systematised the recognised species by means of easily observed characters, which will afford great help in the determination of specimens.

The number and the great variety of the species of *Asterias* make the genus a very difficult one to deal with, and its subdivision into natural groups has been a long felt desideratum. Professor Bell's scheme is, however, essentially a systematic key, mainly artificial in character, rather than a natural arrangement by affinities; it not unfrequently results that species which are nearly related, and present a close similarity of habit, are widely separated and placed in sections wherein they stand isolated. For a table of specific differences, this perhaps may in some cases be an advantage, though it is decidedly unnatural from a taxonomic point of view.

Whilst fully recognising the excellence and utility of Bell's classification, I venture to think that the two methods—the artificial and the natural—may advantageously be combined, and for the species with which the present Report is concerned, I have formulated a scheme which seems to fulfil these requirements. To discuss the partition of all the species of *Asterias* would demand more space than I should be justified in occupying in this place, and would introduce too large an amount of matter foreign to the Challenger Report.

The groups or alliances of species which I have proposed, may, in my opinion, be regarded as of subgeneric rank. I further believe that some of them may ultimately stand as independent genera, but until more is known of the special anatomy of the species, I refrain from so classifying them.

Synopsis of the Species of Asterias *herein mentioned.*

A. *Asterias rubens* group: Abactinal spinelets numerous, but not arranged in definite order, usually small and often more or less grouped. Papulæ numerous, in groups . . . . . ASTERIAS.

a. Heteractinid: Having six rays.

a. Diplacanthid: Armature of the adambulacral plates consisting of two spines.

α. Rays long and tapering, spinulation characteristically vesiculated. No spinelets between the parambulacral series of papulæ . . . . . *vesiculosa.*

β. Rays much shorter and less tapering. Spinulation not specially vesiculated. Occasional spinelets between the parambulacral series of papulæ . . . . *meridionalis.*

[1] *Proc. Zool. Soc. Lond.*, 1881, pp. 492–515.

b. Monacanthid: Armature of the adambulacral plates consisting of one spine.
α. Abactinal spinelets isolated, with large pedicellariæ interspersed . . . . . *perrieri.*

b. Pentactinid: Having five rays.
a. Diplacanthid: Armature of the adambulacral plates consisting of two spines.
α. Spiniferous actinal plates contingent on the adambulacral plates, and bearing an oblique series of three spinelets. Spinelets generally with a high-mounting, abruptly-terminating sheath of membrane surmounted by a wreath of pedicellariæ . . . . *torquata.*
β. Spiniferous actinal plates well spaced from the adambulacral plates, and bearing only one or two spinelets.
i. With a vertical lateral wall.
1. Abactinal spines with vesiculated pedicellariæ, forming tuft-like groups. Armature of the adambulacral plates regularly diplacanthid . . . . . *glomerata.*
2. Abactinal spines not surrounded by vesiculated pedicellariæ, and, though pedicellariæ are numerous, they do not form tuft-like groups. Armature of the adambulacral plates alternately or irregularly diplacanthid and monacanthid . . *rubens.*
ii. With an angular margin. Abactinal spines isolated. Pedicellariæ not vesiculated and more or less distributed.
1. Supero-marginal plates with a single longitudinal series of spines . . . . *versicolor.*
2. Supero-marginal plates with a grouped series of spines . . . . . *amurensis.*
b. Monacanthid: Armature of the adambulacral plates consisting of one spine.
α. Abactinal spinelets isolated, and having large isolated forcipiform pedicellariæ interspersed . . . . *cunninghami.*

B. *Asterias sulcifera* group: Several series of actinal intermediate plates present, bearing spinelets which form regular longitudinal and transverse series. Madreporiform body echinoplacid (Bell) . . Sub-gen. COSMASTERIAS.
a. Abactinal spines vesiculated. Numerous large forficiform pedicellariæ on the abactinal surface . . . . . *tomidata.*
b. Abactinal spines not vesiculated. Forficiform pedicellariæ absent on the abactinal surface or of rare occurrence and not remarkably large . . *sulcifera.*

C. *Asterias scalprifera* group: Armature of the adambulacral and infero-marginal plates consisting of flattened spines, forming transversely or obliquely placed combs. Abactinal plating forming a sub-compact network. Spinelets numerous and grouped . . . Sub-gen. SMILASTERIAS.
a. Armature of the adambulacral plates consisting of three spines. Infero-marginal plates with oblique combs of four spines . . . *scalprifera.*

b. Armature of the adambulacral plates consisting of two spines. Infero-marginal plates with oblique combs of three spines . . . . *triremis.*

D. *Asterias ophidion* group: Abactinal plating forming a delicate, wide-meshed, quadrate network. Spinelets small, isolated, and few in number. Pedicellariæ isolated . . . . . Sub-gen. HYDRASTERIAS.

a. Diplacanthid: Armature of the adambulacral plates consisting of two spines . . . . . *ophidion.*

E. *Asterias mülleri* group: Abactinal spinelets small and isolated. Papulæ isolated or very few together . . . . . Sub-gen. LEPTASTERIAS.

a. Rays rather short and broad. Abactinal spines irregularly distributed . . *mülleri.*

b. Rays elongate and narrow. Abactinal spines subregularly arranged in longitudinal lines . . . . . *compta.*

F. *Asterias tenuispina* group: Abactinal spinelets usually definitely arranged; large and isolated, with thick wreaths of pedicellariæ . Sub-gen. STOLASTERIAS.

a. Heteractinid: With more than five rays.

a. Monacanthid: Armature of the adambulacral plates consisting of one spine.

α. Infero-marginal plates with two spines. With one or more intermediate series of abactinal spines between the median radial and the marginal series.

i. With two abactinal intermediate series of spines. Wreaths of pedicellariæ flat and wide, not raised. Large isolated forficiform pedicellariæ between. With eleven equal rays . . *gemmifera.*

ii. With one abactinal intermediate series of spines. Wreaths of pedicellariæ, thick and bushy, raised. No forficiform pedicellariæ between. With seven to nine rays, usually unequal.

1. With long pointed spines, autacanthid (Bell) . *tenuispina.*

2. With short conical spines, typacanthid (Bell) . *calamaria.*

β. Infero-marginal plates with one spine. No intermediate series of abactinal spines between the median radial and the marginal series . . . . . *volsellata.*

b. Pentactinid: Having five rays.

a. Diplacanthid: Armature of the adambulacral plates consisting of two spines.

α. With two or three complete intermediate series of abactinal spines between the median radial and the marginal series. No intermediate spinelets between the infero-marginal and the adambulacral spines . . . . . *stichantha.*

β. With one incomplete intermediate series of abactinal spines between the median radial and the marginal series. With an intermediate spinelet between the infero-marginal and the adambulacral spines . . *eustyla.*

b. Monacanthid: Armature of the adambulacral plates consisting of one spine.

α. Rays with vertical lateral walls. Median line of abactinal spinelets straight. Intermediate spines few and large . . . . . *glacialis.*

β. Rays, with no definitely defined lateral wall. Median line of abactinal spinelets zigzag. Intermediate spines may be wanting altogether, or may be rather numerous, but small. Rays shorter than in the preceding species . . . . . *africana.*

Chorology of the Genus Asterias.

a. Geographical distribution :—

Atlantic :- Forty-eight or forty-nine species, between the parallels of 82° N. and 40° S.

Asterias grœnlandica, from Greenland and extending northward to Discovery Bay (lat. 81° 41′ N.), from Assistance Bay, Labrador, and Grand Manan, and off the islands of Spitzbergen and Nova Zembla. *Asterias spitzbergensis, Asterias gunneri,* and *Asterias panopla,* from Spitzbergen, the latter extending to the Scandinavian coast and into the Kara Sea. *Asterias hyperborea* and *Asterias normani,* off Beeren Island. *Asterias linckii,* between Beeren Island and Spitzbergen, and extending to the north coast of Norway. *Asterias polaris,* from Greenland and Labrador. *Asterias vulgaris,* extending from Labrador to Cape Hatteras. **Asterias* (*Hydrasterias*) *ophidion,* south of Halifax, Nova Scotia. **Asterias brachiata, Asterias forbesi, Asterias littoralis, Asterias tenera,* **Asterias* (*Leptasterias*) *compta, Asterias lacazii, Asterias tanneri,* and *Asterias briareus,* off the coast of the United States of North America. *Asterias linearis* and *Asterias angulosa,* from the Alligator Reefs off Florida. *Asterias contorta, Asterias fascicularis,* and *Asterias gracilis,* from the West Indian Islands. *Asterias mexicana,* from Vera Cruz. *Asterias hartii,* from Brazil. *Asterias atlantica,* from the Abrolhos reefs and Bermuda, and reported also from Cuba. (The distinction of this species from *Asterias tenuispina* seems doubtful.) *Asterias bellii,* off the eastern coast of Patagonia. *Asterias antarctica, Asterias alba, Asterias obtusispinosa, Asterias verrilli,* **Asterias glomerata,* and **Asterias cunninghami,* from the Strait of Magellan, the latter also from the Falkland Islands, and passing to Tom Bay, in the Pacific area of the Strait. *Asterias spirabilis,* from the Falkland Islands. *Asterias rugispina,* from Tierra del Fuego and Port Famine, Strait of Magellan. *Asterias georgiana* and *Asterias steineni,* from the Island of South Georgia.

Passing now to the northern area on the eastern side, *Asterias disticha,* from the Kanin Peninsula, White Sea. **Asterias* (*Stolas-*

terias) *glacialis*, from Finmark, Iceland, along the coast of Europe into the Mediterranean, and extending to the Canary and Cape Verde Islands. **Asterias* (*Leptasterias*) *mülleri*, from Finmark, the coast of Norway, and the north of the British area. *Asterias hispida*, *Asterias violacea*, and *Asterias rubens*, from the British area, the last reputed to extend to Senegal. *Asterias richardi* and **Asterias* (*Stolasterias*) *tenuispina*, from the Mediterranean, the latter extending to Madeira, the Canary and Cape Verde Islands, and Bermuda. **Asterias* (*Stolasterias*) *eustyla*, from Nightingale Island. **Asterias* (*Stolasterias*) *africana*, *Asterias capensis*, and *Asterias rarispina*, from the Cape of Good Hope.

Indian Ocean: Two or three species between the parallels of 0° and 40° S.

Asterias borbonica, from the Island of Bourbon. **Asterias* (*Stolasterias*) *calamaria*, from Mauritius, and extending to Australia and New Zealand, thus passing into the Pacific. *Asterias fungifera* bears only the vague record of "Australia"; it may therefore be not correctly included in the Indian Ocean fauna.

Southern Ocean: Six species between the parallels of 40° and 60° S.

**Asterias perrieri*, *Asterias studeri*, *Asterias rupicola*, and **Asterias meridionalis*, from Kerguelen Island, the last-mentioned also from Heard Island. **Asterias* (*Smilasterias*) *scalprifera*, from Heard Island and Marion Island. **Asterias* (*Smilasterias*) *triremis*, between Kerguelen and Heard Island.

Eastern Archipelago: Three species between the parallels of 20° N. and 20° S.

Asterias nuda, from Torres Strait. **Asterias vesiculosa*, from the Arafura Sea, north-west of the Arrou Islands. **Asterias* (*Stolasterias*) *volsellata*, off Zebu, Philippine Islands.

Pacific: Fifty-one (and perhaps fifty-four) species between the parallels of 70° (?) N. and 60° S.

Asterias cribraria, from the Arctic Seas north of Bering Strait. *Asterias acervata*, from Bering Strait. *Asterias camtschatica*, *Asterias ochotensis*, and *Asterias pectinata*, from Kamtschatka. **Asterias amurensis*, from the Gulf of Tartary, and extending to Japan. *Asterias japonica*, *Asterias rollestoni*, **Asterias torquata*, **Asterias versicolor*, and **Asterias* (*Stolasterias*) *stichantha*, from Japan. *Asterias acutispina*, off the Island of Oosima. **Asterias* (*Stolasterias*) *calamaria* from Australia and New Zealand, and extending into the Indian Ocean. *Asterias fungifera* is reputed to be from Australia, but the exact locality is unknown, and its reference to the

Pacific fauna is therefore not certain. *Asterias scaber*, *Asterias fragilis*, and *Asterias mollis*, from New Zealand. *Asterias sinusoida*, from Tasmania. **Asterias* (*Stolasterias*) *gemmifera*, from the Fiji Islands, and extending to Chili. *Asterias rodolphi*, from the Kermadec Islands.

Passing to the northern area on the eastern side, *Asterias epichlora*, *Asterias janthina*, and *Asterias ochracea*, from the Island of Sitcha, the first extending to Puget Sound and the coast of Oregon, and the last to San Francisco. *Asterias vancouveri*, from Vancouver Island. *Asterias conferta*, *Asterias hexactis*, *Asterias paucispina*, and *Asterias troschelii*, from Puget Sound. *Asterias fissispina*, *Asterias katherinæ*, and *Asterias lütkeni*, from the coast of Oregon. *Asterias æqualis*, *Asterias brevispina*, *Asterias capitata*, *Asterias sertulifera*, *Asterias forreri*, and *Asterias exquisita*, from the coast of California. *Asterias inermis* and *Asterias nautarum*, from Ecuador. *Asterias gelatinosa*, *Asterias fulva*, *Asterias germaini*, *Asterias lurida*, *Asterias mitis*, *Asterias spectabilis*, **Asterias* (*Cosmasterias*) *sulcifera*, *Asterias varia*, *Asterias clavata*, and *Asterias fulgens*, from the coast of Chili. **Asterias* (*Cosmasterias*) *tomidata*, from the Gulf of Peñas. **Asterias cunninghami*, off the coast of Patagonia, and extending through the Strait of Magellan into the Atlantic as far as the Falkland Islands. *Asterias brandti* and *Asterias neglecta*, from the Strait of Magellan. *Asterias philippi* has only the vague record of South America as a locality, and it may not, therefore, be correctly included in the Pacific fauna.

β. *Bathymetrical range:* Shallow water to 1250 fathoms.

Greatest range of one species: *Asterias contorta*, 11 to 860 fathoms (*fide* Perrier).

The majority of the species are confined to the Littoral zone. *Asterias* (*Leptasterias*) *mülleri*, *Asterias* (*Cosmasterias*) *sulcifera*, *Asterias vulgaris*, *Asterias panopla*, *Asterias contorta*, *Asterias fascicularis*, *Asterias gracilis*, *Asterias tanneri*, *Asterias briareus*, *Asterias richardi*, and *Asterias* (*Stolasterias*) *stichantha*, pass into the Continental zone. *Asterias contorta*, *Asterias gracilis*, *Asterias fragilis*, *Asterias vesiculosa*, and *Asterias* (*Hydrasterias*) *ophidion*, occur in the Abyssal zone; the last three being at present known only from that zone. *Asterias* (*Hydrasterias*) *ophidion* is the species attaining the greatest depth, viz. 1250 fathoms.

γ. *Nature of the Sea-bottom:* The character of the habitat of the older known species is recorded in comparatively few cases. The ground inhabited by the Littoral species varies considerably. The following occurrences are recorded. On

Volcanic mud: *Asterias meridionalis, Asterias perrieri, Asterias fascicularis* (also on Volcanic sand), and *Asterias* (*Smilasterias*) *scalprifera*. On Blue mud: *Asterias* (*Cosmasterias*) *sulcifera* and *Asterias* (*Hydrasterias*) *ophidion*. On clay: *Asterias linckii* (also on hard ground), *Asterias panopla, Asterias spitzbergensis, Asterias gunneri*, and *Asterias normani*. On mud: *Asterias brandti, Asterias bellii, Asterias cribraria*. On Green mud: *Asterias vesiculosa* and *Asterias* (*Stolasterias*) *stichantha*. On hard ground, gravel or rock: *Asterias littoralis, Asterias tenera, Asterias* (*Leptasterias*) *compta, Asterias rupicola, Asterias hyperborea, Asterias hartii, Asterias* (*Smilasterias*) *triremis, Asterias cunninghami* (also on sand), and *Asterias acervata*. On Volcanic sand: *Asterias studeri* and *Asterias contorta*. On sand: *Asterias obtusispinosa, Asterias gracilis* (also on hard ground), *Asterias tanneri* (also on mud and shells), *Asterias versicolor*, and *Asterias glomerata*. On Green sand: *Asterias* (*Cosmasterias*) *tomidata*.

The types of the following species are lost and unknown. I consider, therefore, that the names should be discarded :—

Asterias aster, Gray.
Asterias bootes, Müller and Troschel.
Asterias echinata, Gray.
Asterias Wilkinsoni, Gray.

The species collected by the Challenger are indicated in the above list by an asterisk.

Chorological Synopsis of the Species herein mentioned.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Asterias amurensis	Pacific.	5 to 25	... ...
Asterias cunninghami	Atlantic and Pacific.	0 to 55	Rock, kelp, sand.
Asterias glomerata	Atlantic.	12 to 55	Sand, gravel.
Asterias meridionalis	Southern.	10 to 127	Volcanic mud.
Asterias perrieri	Southern.	25 to 110	Volcanic mud.
Asterias rubens	Atlantic.	0 to 53	... ...
Asterias torquata	Pacific.	5 to 25	... ...
Asterias versicolor	Pacific.	8 to 50	Sand.
Asterias vesiculosa	Eastern Archipelago.	800	Green mud.
Asterias (*Cosmasterias*) *sulcifera*	Pacific.	345	Blue mud.
Asterias (*Cosmasterias*) *tomidata*	Pacific.	45	Green sand.
Asterias (*Smilasterias*) *scalprifera*	Southern.	50 to 75	Volcanic mud.
Asterias (*Smilasterias*) *triremis*	Southern.	150	Coarse gravel.
Asterias (*Hydrasterias*) *ophidion*	Atlantic.	1250	Blue mud.
Asterias (*Leptasterias*) *compta*	Atlantic.	18 to 150	Gravel, stones.
Asterias (*Leptasterias*) *mülleri*	Atlantic.	53 to 433	... ...
Asterias (*Stolasterias*) *africana*	Atlantic.	5 to 20	... ...
Asterias (*Stolasterias*) *calamaria*	Indian and Pacific.	0 to 38	... ...
Asterias (*Stolasterias*) *eustyla*	Atlantic.	100 to 150	... ...
Asterias (*Stolasterias*) *gemmifera*	Pacific.	...	Coral reefs.
Asterias (*Stolasterias*) *glacialis*	Atlantic.	...	... ...
Asterias (*Stolasterias*) *stichantha*	Pacific.	345	Blue mud.
Asterias (*Stolasterias*) *tenuispina*	Atlantic.	...	... ...
Asterias (*Stolasterias*) *volsellata*	Eastern Archipelago.	95	... ...

A. *Asterias rubens* group: Asterias *vera*.

1. *Asterias vesiculosa*, n. sp. (Pl. XCIX. figs. 1 and 2; Pl. CIII. figs. 9 and 10).

Rays six. R = 81 mm.; r = 16 mm. R > 5 r. Breadth of a ray at the base, 15 to 16 mm.; breadth about midway between the disk and the extremity, 9 mm.

Rays elongate, subdepressed, tapering from the base to the extremity, the outer part of the ray being narrow and rather attenuate. Disk subdepressed, only slightly inflated; abactinal surface of the rays slightly convex, also slightly convex at the base on the actinal surface, the disk being marked with depressions in the actinal interradial lines. Interbrachial arcs acutely angular.

The abactinal plates are entirely masked. The whole area is beset with isolated, widely spaced, short, robust, obtuse spinelets, each of which is encircled by, and appears to protrude through, a widely expanded puffy vesicle. Occasionally one or more rather large pedicellariæ may be imbedded. No definite order of arrangement can be detected in the disposition of the spinelets. The interspaces between the vesicles are closely crowded with numerous large papulæ, amongst which pedicellariæ are occasionally interspersed, and sometimes the latter are borne on a vesicle resembling in miniature that of the spinelets. Viewed with the naked eye the whole abactinal surface has a coarse, irregularly granular and studded appearance.

The armature of the adambulacral plates consists of two short, robust, cylindrical, slightly tapering, obtuse spinelets, which form two regular longitudinal rows. At the base of the innermost spine, and quite within the furrow, are numerous very large forficiform pedicellariæ. External to the adambulacral plates is a rather wide space covered with a thick, puffy, wrinkled membrane, through which protrude a single longitudinal series of widely spaced and rather large papulæ, and this space is bounded at the margin of the actinal area by a longitudinal series of plates (probably the representatives of infero-marginal plates) upon which are borne one or usually two diagonally placed small spinelets, almost hidden in an expansive vesicle beset with isolated pedicellariæ. Above this series of infero-marginal plates is a wide area which occupies the lateral wall of the rays, covered with thick wrinkled skin, punctured with rather numerous papulæ, and bearing, at least near the base of the rays, large forficiform pedicellariæ. It is bounded superiorly by a regular longitudinal series of plates—the representatives of the supero-marginal series—upon each of which is borne a single rather small spinelet, surrounded by a large, widely expanded vesicle in which are imbedded from three to five pedicellariæ. Here and there upon the abactinal surface and elsewhere may be seen isolated and very large forficiform pedicellariæ usually on a vesicular base.

The madreporiform body, which is situated about midway between the centre of the disk and the margin, has its surface grooved with fine convoluted striations.

The ambulacral furrows are wide, and the tube-feet, which are arranged quadriserially, have a button-like, centrally invaginated terminal disk.

Colour in alcohol, a dirty brownish grey, probably indicative of a purplish colour when alive.

Locality.—Station 191. In the Arafura Sea, north-west of the Arrou Islands. September 23, 1874. Lat. 5° 41′ 0″ S., long. 134° 4′ 30″ E. Depth 800 fathoms. Green mud. Bottom temperature 39°·5 Fahr.; surface temperature 82°·2 Fahr.

Remarks.—*Asterias vesiculosa* is unlike any of the six-rayed forms at present known; its long, tapering rays, and the peculiar vesiculated character of the abactinal and lateral areas, readily distinguish it from the other species.

2. *Asterias meridionalis*, Perrier.

Asterias meridionalis, Perrier, 1875, Révis. Stell. Mus., p. 76 (Archives de Zool. expér., t. iv. p. 340).

Localities.—Station 149D. Off Royal Sound, Kerguelen Island. Depth 25 and 28 fathoms. Volcanic mud.

Station 149E. Off Cape Maclear, Kerguelen Island. Depth 30 fathoms. Volcanic mud.

Station 149H. Off Cumberland Bay, Kerguelen Island. Depth 127 fathoms. Volcanic mud.

Off Kerguelen Island. Depth 10 to 50 fathoms. Volcanic mud.

Off Marion Island. Depth 50 fathoms. Volcanic sand.

3. *Asterias perrieri*, Smith.

Asterias Perrieri, Smith, 1876, Ann. and Mag. Nat. Hist., ser. 4, vol. xvii. p. 106; Phil. Trans., Zool. Kerguelen Island, 1879, vol. clxviii. p. 273, pl. xvi., figs. 2, 2*a*, 2*b*.
Othilia sexradiata, Studer, 1876, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, p. 458.

Localities.—Station 149D. Off Royal Sound, Kerguelen Island. Depth 25 and 28 fathoms. Volcanic mud.

Off Kerguelen Island. Depth 110 fathoms. Volcanic mud.

Remarks.—The largest of the type examples of this species preserved in the British Museum is remarkable from the fact (observed by Mr. Edgar A. Smith) that it "has a cluster of some hundreds of young ones clinging to its ventral disk." On examining this specimen recently, with a view to ascertain the nature of the attachment, I came to the conclusion that this frequently observed but hitherto unexplained position of the young of certain species of *Asterias* in the region of the mouth is due to the fact that the ovarial tubules are ejected through the actinostomial opening, and that the ova then complete their development *in situ*, the embryos remaining attached to the mother by means of the primitive connection of their "larval organ" with the now disintegrated filaments of the ovarial membrane.

4. *Asterias torquata*, n. sp. (Pl. CII. figs. 1–4).

Rays five. R = 76 mm.; $r = 9$ mm. $R > 8r$. Breadth of a ray at the base, 11·5 mm.; breadth at 10 mm. from the base, 15·5 mm., and midway between the disk and the extremity, 14 mm.

Rays long in proportion to the disk, broad and stout, tapering very slightly on the inner two-thirds, then rather rapidly on the outer third; abruptly constricted laterally at the base, where the rays appear crushed together and give at first sight a false appearance of a larger size to the disk than is actually the case. Junction of the base and disk marked abactinally by a slight depression, where the rays easily separate.

The abactinal area is beset with plates which bear single, isolated, short, robust spinelets, very slightly tapering and obtusely rounded at the tip. The spines are covered fully half their length with a thick membranous sheath which rises perpendicularly and terminates abruptly, and its free margin is beset with a regular circlet of large uniform forcipiform pedicellariæ. Occasionally round the large spines the circlet may be doubled or a few additional pedicellariæ may be present. The spines are widely spaced, and the intervening membrane is naked. It is punctured by numerous papulæ in groups of four or five. In some examples the median radial series of plates is distinctly traceable, and may be even conspicuous, in consequence of the presence of two or three spinelets on a plate placed in line transverse to the direction of the ray.

The armature of the adambulacral plates consists of two short, rather delicate, slightly tapering, obtusely-tipped, equal spinelets, which form two longitudinal rows. No pedicellariæ are present. Immediately external to the adambulacral plates is a slightly oblique transverse series of three equal spinelets borne on an actinal plate (? infero-marginal) which form three longitudinal rows. The spinelets are spaced apart, but rather closely; they are rather longer and much more robust than the armature of the adambulacral plates, slightly tapering and obtusely tipped, and each is covered with a membranous sheath which extends nearly to the tip, terminates abruptly, and bears on the margin at the outer side of the spine a few forcipiform pedicellariæ which are most numerous on the outermost of the three spinelets. This series of spinelets is separated by a very narrow space occupied by papulæ, and at wide intervals apart, on the inner part of the ray, by an occasional rather large forficiform pedicellaria, from a subregular longitudinal series of spinelets, which is perhaps the representative of a supero-marginal series, but is in no way distinguishable from the spinelets of the abactinal plates generally, excepting in its more regular longitudinal disposition.

The actinal interradial regions are narrow and devoid of spinelets, but may bear one or more forficiform pedicellariæ.

The madreporiform body is distinct and situated close to the margin; it is surrounded by a circlet of well-spaced spinelets, similar in all respects to those on the abactinal surface generally, with sheath and pedicellariæ. Its surface is grooved with fine convoluted striations.

Colour in alcohol, a bleached yellowish grey.

Locality.—Off Yokohama, Japan. Depth 5 to 25 fathoms.

Remarks.—This species is characterised by the isolated abactinal spinelets, with the high-mounting, abruptly terminating, sheath of membrane surmounted by a wreath of pedicellariæ, and by the presence of the oblique series of three spinelets on the actinal plates immediately external to the adambulacral plates. The general facies of the form is different from that of the other pentactinid species of *Asterias*.

There is an example of this species in the Leyden Museum, from Japan, collected by Von Siebold, which I have had the opportunity of studying through the kindness of the late Professor Schlegel and Dr. Jentinck. It is labelled "*Asteracanthion rubens*," and is stated to have been determined by Troschel; the presence of examples of that species from Japan in the Leyden collection being recorded in the System der Asteriden (p. 17). I find two figures, but rather unsatisfactory, of this example on the proof of one of the unpublished plates of Echinodermata intended for the "Fauna japonica" (Echinodermata, Tab. vi. figs. 3 and 4). This section, unfortunately, was never completed. Other examples of *Asterias* in the same collection, labelled "*Asteracanthion rubens*," also brought by Von Siebold from Japan, and probably determined at the same time as the above, are the *Asterias amurensis* of Lütken.

5. *Asterias glomerata*, n. sp. (Pl. CV. figs. 1–4).

Rays five. R = 95 mm.; r = 14 mm. R < 7 r. Breadth of a ray near the base, 17 mm.

Rays elongate, thick, robust, broad at the base, tapering to the extremity, which is pointed but not attenuated. Lateral walls nearly vertical. Rays slightly convex abactinally. Disk small, the rays appearing crushed together at their base. Interbrachial arcs acute.

The abactinal plates present no definite order of arrangement, though an irregular and often much angulated median radial line may frequently be more or less clearly traced. Each plate bears a single, short, moderately robust, truncate spinelet surrounded by from five to eight or nine large pedicellariæ with vesicular bases, the whole group having the appearance of a more or less prominent tuft of coarse papilliform granules, the central spinelet being most prominent. In the interspaces between the tufts are numerous, closely crowded papulæ, and large forficiform pedicellariæ are present here and there. The abactinal area is bounded by a regular longitudinal series of supero-marginal plates, which bear a single spinelet and resemble the abactinal plates above described, excepting that the spinelet is rather more prominent and more robust, and the encircling group of pedicellariæ rather larger. In large specimens two spinelets are occasionally present about the middle or towards the extremity of the ray. Between the supero-marginal and infero-marginal series of plates is a wide space devoid of spinelets, which stands in the vertical

lateral wall of the ray, and is occupied by groups of large papulæ, six or more in each, and an occasional large forficiform pedicellaria. The infero-marginal plates, which stand at the angular junction of the actinal and lateral surfaces of the ray, bear normally an obliquely placed pair of equal, robust, truncate spinelets, slightly compressed at the tip, which have a group of large pedicellariæ on their outer side similar to those above described. Between these and the adambulacral plates is a series of isolated spinelets of the same size as the oblique pair, but not compressed, and so placed that each appears to form a trio with the pair. They bear on their outer side several large pedicellariæ, and are separated by papulæ.

The armature of the adambulacral plates consists of two equal, short, obtusely tipped, cylindrical, skin-covered spinelets, which radiate apart and form two regular longitudinal series. Within the furrow is a series of rather large forficiform pedicellariæ on membranous pedicles, but they are entirely hidden from view when the inner series of spinelets on the adambulacral plates are directed towards, or partly over, the furrow.

The median interradial line, and a space extending on each side, is devoid of spinelets or papulæ, and is occupied only by a few isolated forficiform pedicellariæ which, by their form, simulate conical, sharply pointed spinelets.

The madreporiform body, which is rather near the margin, is difficult to find, being often almost hidden by the vesiculated tufts of pedicellariæ which surround the spinelets borne on the adjacent abactinal plates; there is, however, no special circlet of spinelets round the madreporite.

The ambulacral tube-feet are crowded and quadriserial in arrangement.

Colour in alcohol, a bleached brownish or yellowish white.

Localities.—Station 313. Near the Atlantic entrance to the Strait of Magellan. January 20, 1876. Lat. 52° 20′ 0″ S., long. 67° 39′ 0″ W. Depth 55 fathoms. Sand. Bottom temperature 47°·8 Fahr.; surface temperature 48°·2 Fahr.

Station 315. Port William, Falkland Islands. January 26, 1876. Lat. 51° 40′ 0″ S., long. 57° 50′ 0″ W. Depth 12 fathoms. Sand, gravel. Surface temperature 50°·0 Fahr.

Remarks.—This species presents a close resemblance in its general habit to *Asterias meridionalis*, but is distinguished by having only five rays, by the tuft-like character of the abactinal spinelets with the vesiculated pedicellariæ, and by the regular presence of an intermediate series of well-developed spines, with pedicellariæ, between the infero-marginal and adambulacral spines.

6. *Asterias rubens*, Linné.

Asterias rubens, Linné, 1766, Systema Naturæ, ed. xii. p. 1099.
Asterias glacialis, Pennant, 1777, British Zoology, vol. iv. p. 60.
Asterias clathrata, Pennant, 1777, British Zoology, vol. iv. p. 61.
Asterias holsatica, Retzius, 1805, Dissert. sist. spec. cog. Asteriarum, p. 22.

Asterias minuta, Retzius, 1805, Dissert. sist. spec. cog. Asteriarum, p. 24.
Stellonia rubens, Nardo, 1834, De Asteriis, Oken's Isis, p. 716.
Asteracanthion rubens, Müller and Troschel, 1840 (April), Monatsber. d. k. preuss. Akad. d. Wiss, Berlin, p. 102.
Uraster rubens, Forbes, 1841, Hist. Brit. Starfishes, p. 83.

Locality.—"Knight Errant" Expedition:

Station 3. Off the Island of North Rona. August 3 and 4, 1880. Lat. 59° 12′ N., long. 5° 57′ W. Depth 53 fathoms.

Remarks.—One of the examples (a large specimen) obtained at this station is remarkable for the elongation and attenuation of the rays, and for the comparative paucity and smallness of the abactinal spinelets. These are minute, conical, and almost hidden in the membrane. The margin of the abactinal area is bounded by a regular and prominent line of spinelets, and the median radial line is also more or less regular. The other spinelets are quite irregular in disposition, and though moderately numerous, are inconspicuous in consequence of their small size. The sides of the rays are deeper and more perpendicular than usual. The lateral spines, borne on the infero-marginal plates, are two or three in number, and are placed obliquely. No spines are present on the sides of the ray between these spines and the supero-marginal series, and there are no spines between the infero-marginal series and the adambulacral spines. Forficiform pedicellariæ are very numerous on the adambulacral spines, especially on the inner portion of the furrow, also on the sides of the ray. They are smaller and less numerous on the abactinal area. Forcipiform pedicellariæ are comparatively scanty, a few occurring at the base of the supero-marginal spines and a greater number at the base of the lateral or infero-marginal spines; and a few are irregularly distributed over the abactinal area. This specimen in some respects simulates the habit of *Asterias glacialis* in a striking manner. Other examples dredged at the same locality are quite normal in character and appearance.

7. *Asterias versicolor*, n. sp. (Pl. CIV. figs. 1–4).

Rays five. R = 71 mm.; r = 19 mm. R < 4 r. Breadth of a ray near the base, 22 mm.

Rays well produced, broad, slightly constricted laterally at the base, tapering gradually to a pointed extremity, subdepressed, abactinal surface convex, actinal surface more or less flat, margin angular. Interbrachial arcs acute. Disk well developed, convex.

The abactinal area is covered with moderately robust plates which form a subregular, rather widely meshed network. Upon the plates are borne widely spaced, isolated, short spinelets. A median radial series is more or less clearly indicated, but is rarely continuous or regular, and two intermediate irregular series are present on each side between the median radial line and the marginal series of plates. The spines, which are robust and truncate, often channelled near the tip, and sometimes slightly crenulate and denticulate, occupy the centre of a low but rather broad and slightly convex boss; at the base of the

spine are a number of small forcipiform pedicellariæ, which form an ill-defined wreath, and on the boss are distributed a number of isolated, small forficiform pedicellariæ. In the interspaces or meshes of the network are numerous thin, pointed papulæ, and a few small forficiform pedicellariæ are interspersed. A regular longitudinal row of plates form the margin of the abactinal area, which I consider to be the representatives of supero-marginal plates. Each bears a single short, robust, truncate spinelet, which is distinctly channelled or gauge-shaped, and at the base, on the abactinal side, is a moderately thick half-wreath of forcipiform pedicellariæ. There are seldom any of these found on the actinal side, but several forficiform pedicellariæ may be there instead. In some examples two spines placed diagonally, or even three spines, may be present on a greater or less number of the plates, usually only here and there, and never continuous throughout the ray or sufficient to form the crowded margin characteristic of *Asterias amurensis*.

The actinal area of the ray, which extends from the supero-marginal plates above described to the adambulacral plates, is broad and bears midway one double longitudinal series of spines, composed of spines standing in oblique, well-spaced pairs. The spines are equal, robust, truncate, often channelled, and are accompanied on their outer side by a little tuft of forcipiform pedicellariæ. In the wide space on each side of this median series of spinelets are numerous papulæ and a few isolated forcipiform pedicellariæ.

The armature of the adambulacral plates consists of one spine and two spines alternately, so arranged that at first sight there appears to be a single series only; the single spine and the outer spine of the pairs standing erect and forming a straight regular series, whilst the inner spine of the pairs is placed high in the furrow, and directed horizontally between adjacent tube-feet, and is in consequence generally hidden. The inner spine of the pairs is more delicate than its companion. The outer spine and the solitary spine are equal in size, slightly compressed, truncate at the tip, and sometimes channelled, at least near the mouth; on the outer part of the ray they are more tapering. Three or four small, elongate, forficiform pedicellariæ are attached near the tip on the outer side of all these spinelets.

The ambulacral tube-feet are quadriserially arranged.

The madreporiform body is circular, and is placed rather nearer the margin than the centre of the disk. Its surface is slightly convex, and is marked with very fine striations which radiate centrifugally with considerable regularity. There are no spinelets round the periphery of the organ, but two or three isolated forficiform pedicellariæ may be present.

Colour in alcohol, a bleached yellowish white on the actinal surface; on the abactinal surface the spinelets and an area round their base occupied by the slightly convex boss are a bleached yellowish white, but the interspaces are a uniform dark chocolate brown, the sharply defined colouration giving a very striking character to the species. In one example the whole abactinal surface, excepting only the tips of the spinelets, is a uniform rich dark

chocolate brown, the colour extending on the actinal surface up to the median longitudinal series of spines borne on the infero-marginal plates.

Young Phase.—In the young form of this species the rays are not so strikingly angular at the margin as in the adult. In a small example in which R measures 10 mm., the armature of the adambulacral plates appears to form only a single series. The two obliquely placed spines on the infero-marginal plates which form the conspicuous intermediate series on the actinal surface of the adult, are at this stage quite at the margin, and the spines appear large and robust in relation to the size of the starfish. The supero-marginal plates bear each a single spinelet. The spinulation of the abactinal surface already shows the character of the adult.

In a rather larger stage, when R measures 15 mm., a second spinelet is beginning to be developed on alternate adambulacral plates, but it is as yet only very small, and the inner spinelet on these plates is more inclined over the furrow than the single spinelet on the alternate plates, which causes the appearance of two alternating series of spinelets. The infero-marginal spines have not yet left their marginal position.

Locality.—Stations 233 and 233A. Off Kobé and Awadji Sima, Japan. Depth 8 to 50 fathoms. Mud and sand.

Remarks.—This species is a near ally of *Asterias amurensis;* the difference, however, in the armature of the supero-marginal plates, the character of the adambulacral armature, and the prominence of the abactinal spinelets appear to me to justify their being regarded as distinct species.

8. *Asterias amurensis*, Lütken.

Asterias amurensis, Lütken, 1876, Videnskab. Medd. naturh. Foren. i Kjøbenhavn, p. 296.

Locality.—Yokohama, Japan. Depth 5 to 25 fathoms.

Remarks.—I have referred several specimens collected at Yokohama to Lütken's species, although they do not seem to present some of the characters mentioned in his description so strongly marked as in the types which I had the opportunity of examining in Copenhagen, and in other examples which I have seen elsewhere. They appear to me to hold an intermediate position in some respects between the typical form of *Asterias amurensis* and *Asterias versicolor*, and I am inclined to think that they may represent a locational variety. The species, however, is one which shows considerable variation, and I do not feel that the material at my disposal is sufficient to enable me to do more at present than place on record the opinions above expressed.

It is probable that some of the starfishes from Japan which have been referred to *Asterias rubens* belong either to *Asterias amurensis* or *Asterias versicolor;* and others are examples of the species described above (p. 570) under the name of *Asterias torquata*.

9. *Asterias cunninghami*, Perrier.

Asterias Cunninghami, Perrier, 1875, Révis. Stell. Mus., p. 75 (Archives de Zool. expér., t. iv. p. 339).

Localities.—Station 313. Near the Atlantic entrance to the Strait of Magellan. January 20, 1876. Lat. 52° 20′ 0″ S., long. 67° 39′ 0″ W. Depth 55 fathoms. Sand. Bottom temperature 47°·8 Fahr.; surface temperature 48°·2 Fahr.

Station 315. Port William, Falkland Islands. January 26, 1876. Lat. 51° 40′ 0″ S., long. 57° 50′ 0″ W. Depth 12 fathoms. Sand, gravel. Surface temperature 50°·0 Fahr.

B. *Asterias sulcifera* group: Subgenus COSMASTERIAS, nov.

10. *Asterias* (*Cosmasterias*) *tomidata*, n. sp. (Pl. CV. figs. 8–10).

Rays five. R = 92 mm.; $r = 19$ mm. $R < 5r$. Breadth of a ray near the base, 21 mm. Larger examples are in the collection, which measure about R = 110 mm., but are too much contorted in their present state for careful measurement.

Rays elongate, robust, inflated, tapering gradually from the base to the pointed extremity, which is rather attenuate. Disk rather small, more or less inflated, with deep contracted sulci on the outer part of the median interradial lines, the rays appearing closely crushed together at their base, and causing the disk to seem smaller than is really the case. At the base of the ray there is sometimes a transverse depression, emphasising the distinction of disk and ray. The interbrachial arcs are acute.

The abactinal area is covered with rather small plates, amongst which five regular longitudinal series may be defined, and two less regular series on each side of the median radial series. The median radial series forms a slightly raised rib which proceeds from the disk to the extremity, and each of the plates bears three or four small, short, truncate spinelets, with crowded membranous vesicles at their base. These spinelets are not definitely arranged, although their general disposition forms an irregular transverse series. Small isolated forcipiform pedicellariæ are present with each group. On the small plates which succeed the median radial series there are not more than one or rarely two spinelets, and small isolated forcipiform pedicellariæ. Owing to the small size and the irregularity in position of these plates, the spinelets in this region have a tendency to form an indistinct reticulation. The plates of the two succeeding series, which form regular longitudinal lines along the ray, may bear two or three spinelets, accompanied by isolated forcipiform pedicellariæ. Between the outermost series of these plates and the adambulacral plates there are at the base of the ray about four longitudinal series of small contingent plates, which bear larger and more robust spines than elsewhere on the test. At the base of the ray these actinal spines form transverse series of four, but doubling is not unfrequent, and the arrangement shows a tendency to fall into oblique pairs; and on the

outer part of the ray there are probably not more than one or two of these pairs, or even single spines, present.

The papular areas, which contain numerous papulæ, form regular longitudinal lines along the ray, except amongst the irregularly disposed plates, and there is frequently placed near their margin a large, coarse, subtriangular, forficiform pedicellaria, very blunt and broad at the apex, having on its margin four or five coarse interlocking denticles.

The armature of the adambulacral plates consists of two rather short, slightly compressed, slightly tapering, obtusely pointed, equal spinelets, which radiate apart and form two regular rows. At the base of the innermost, and placed quite within the furrow, are a number of small forficiform pedicellariæ.

The madreporiform body is small and rather nearer the margin than the centre of the disk. Its periphery is surrounded by a close circlet of sixteen or more short equal spinelets with vesicles at their base, and a few small forcipiform pedicellariæ.

The ambulacral tube-feet are quadriserially arranged, and have a deeply invaginated terminal fleshy disk.

Colour in alcohol, a bleached yellowish white.

Locality.—Station 304. South of Port Otway, Gulf of Peñas. December 31, 1875. Lat. 46° 53′ 15″ S., long. 75° 12′ 0″ W. Depth 45 fathoms. Green sand. Surface temperature 57°·2 Fahr.

Remarks.—This species appears to be nearly allied to *Asterias spectabilis*, Philippi, sp., with which I at first supposed it to be identical. After a careful study of the series of specimens collected by the Challenger, however, this seems to be impossible, so far as I can judge from Dr. Philippi's description alone, for no figures are given, and I have not been able to find any authenticated examples of his species in European collections.

Notwithstanding the many points in which the description[1] of *Asterias spectabilis* coincides with the present form, it is stated that the plates of the third series of abactinal plates from the median series bear only single spines, whereas in the Challenger examples above described three or more are always present. The pedicellariæ in *Asterias spectabilis* are stated to be very numerous, and apparently smaller than in the allied species, neither of which remarks seem to me applicable to *Asterias* (*Cosmasterias*) *tomidata;* furthermore, no mention is made of the comparatively numerous and extraordinarily large forficiform pedicellariæ, which could not possibly have escaped the eye of such a careful observer as Dr. Philippi had they been present in his form. On these grounds I consider the species to be distinct. It is not without great reluctance that I have added a new specific name to the already long list of Chilian forms which have a place in literature, but any of which I have failed to recognise definitely amongst the numerous series collected in that region that I have examined.

[1] *Archiv f. Naturgesch.*, 1870, Jahrg. xxxvi., Bd. i. p. 271.

11. *Asterias* (*Cosmasterias*) *sulcifera* (Valenciennes, M.S.), Perrier.

Asteracanthion sulcifer (Valenciennes, M.S.), Perrier, 1869, Ann. Sci. Nat., 5e Série, t. xii. p. 235, pl. 1, figs. 14, *a*, *b*, *c*.

Asterias sulcifer, Perrier, 1875, Révis. Stell. Mus., p. 58 (Archives de Zool. expér., t. iv. p. 322).

Locality.—Station 306A. In the Messier Channel, between Wellington Island and the west coast of Chili. January 2, 1876. Lat. 48° 27′ 0″ S., long. 74° 30′ 0″ W. Depth 345 fathoms. Blue mud. Bottom temperature 46°·0 Fahr.; surface temperature 57°·5 Fahr.

Remarks.—There are several large examples from the Messier Channel which I have referred to this species. They accord exactly with the description given by Perrier, and appear to me to resemble more closely the type specimens preserved in the Jardin des Plantes, at Paris, than those in the British Museum. It is not improbable that the latter may have to be ranked as a variety. The differences affect the number and size of the spinelets—characters, however, in which nearly every example shows some variation.

C. *Asterias scalprifera* group: Subgenus SMILASTERIAS, nov.

12. *Asterias* (*Smilasterias*) *scalprifera*, n. sp. (Pl. C. figs. 4–6; Pl. CIII. figs. 1 and 2).

Rays five. R = 58 mm.; r = 8 mm. R > 7 r. Breadth of a ray a little beyond the base, 11·5 mm.

Rays elongate, subcylindrical, rather swollen near the base, but not abruptly, thence tapering gradually to the extremity. Disk small, convex and high. Interbrachial arcs acutely angular, the rays appearing to be crushed together at the base.

The abactinal area is beset with small plates, the majority of which are nearly as long as broad. A median radial series of plates rather larger than the others proceeds regularly and uninterruptedly from the disk to the extremity. The plates on each side of this cannot be said to form regular longitudinal lines, though a tendency towards this arrangement appears to be present; a transverse correspondence of the plates is much more distinctly traceable. The plates bear a number of small, low, round-tipped, equal, papilliform spinelets, which are widely spaced upon the plate, and amongst them are large forcipiform pedicellariæ widely spaced and isolated, and nearly as large as the spinelets, from which they can only be distinguished by careful examination with a magnifying-glass. No definite order of arrangement of the spinelets and pedicellariæ on the plates is to be observed, but owing to the presence of indistinct transverse wrinkles and sutures, and the transverse correspondence of plates above mentioned, a certain general transverse character is given to the disposition of the spinulation as a whole. One or two papulæ are present in the interspaces between the plates.

The armature of the adambulacral plates consists of three spinelets closely placed at the base, but radiating a little apart, and forming a transverse and very slightly oblique

series on each plate. The spinelets are equal in length, slightly compressed, broad, chisel-shaped, and truncate at the tip.

Immediately external to the adambulacral plates follows a series of actinal (? infero-marginal) plates, upon which are borne four spinelets, closely placed at the base, radiating slightly apart, forming a very oblique series upon the plate, the base line being at an angle of 45° to the margin of the furrow; these spinelets are equal, broad, more compressed than those on the adambulacral plates, slightly flaring, chisel-shaped, and truncate at the tip. No pedicellariæ are associated either with these spinelets, or with those forming the armature of the adambulacral plates. This series of actinal (? infero-marginal) plates is separated from the next above by a narrow space in which papulæ are present. The succeeding series, which is perhaps the representative of a series of supero-marginal plates, forms a regular longitudinal line, and the spinulation of the plates is precisely similar to that on the abactinal plates generally, excepting that a single spinelet near the inferior edge of each plate is a trifle longer and is flattened, truncate and chisel-shaped at the tip, simulating in miniature the chisel-shaped spines on the actinal and adambulacral plates. This single spine on each plate forms a regular series along the ray, but is so small that it is scarcely noticeable without a magnifying-glass.

The madreporiform body, which is remarkably small and situated near the margin at the summit of the almost vertical interbrachial arc, is surrounded by a closely packed circlet of rounded papilliform spinelets. It is elliptical or circular in shape, and the surface, which is slightly concave, is grooved with fine radiating striations.

Colour in alcohol, greyish white, with traces of a purplish colour on the abactinal surface in the case of a large example. In a smaller specimen the purple colour is more fully preserved.

Localities.—Off Marion Island. Depth 50 fathoms.

Station 151. Off Heard Island. February 7, 1874. Lat. 52° 59′ 30″ S., long. 73° 33′ 30″ E. Depth 75 fathoms. Volcanic mud. Surface temperature 36°·2 Fahr.

Remarks.—This species is distinguished by the transverse series of three flattened spinelets on the adambulacral plates, and by the presence of the remarkable obliquely placed combs of four flattened spinelets on the infero-marginal plates. The character of the abactinal plating and spinulation is also characteristic, and produces a habit distinctly different from that of any other species except *Asterias* (*Smilasterias*) *triremis*.

13. *Asterias* (*Smilasterias*) *triremis*, n. sp. (Pl. CI. figs. 5 and 6; Pl. CII. figs. 5 and 6).

Rays five. R = 35 mm.; $r = 5{\cdot}5$ mm. $R > 6\,r$. Breadth of a ray at the base about 7 mm.

Rays elongate, tapering, convex, and apparently subcylindrical abactinally, but flattened actinally. Disk small and convex, often more or less tumid and higher than the base of the rays. Interbrachial arcs acute.

The abactinal area is covered with small plates, the major diameter of which is usually transverse in relation to the ray, showing a more or less distinct tendency to form longitudinal series along the ray. A median radial series is more or less indistinctly indicated by a faint ridge, and on the sides of the rays a regular arrangement in longitudinal as well as transverse series occurs. Several small, uniform, papilliform spinelets are borne on each plate, well spaced apart, and several small forcipiform and forficiform pedicellariæ which at first sight can hardly be distinguished from the spinelets; the whole forms a uniform papillose covering to the abactinal surface in which no definite order of arrangement can be detected. On the plates that I consider to be the representatives of the supero-marginal plates there are generally one or two spinelets definitely placed, which may stand as an oblique pair, the series forming a regular longitudinal line along the ray. Between the supero-marginal and the infero-marginal plates, there are on the inner part of the ray in large examples one or two series of intermediate plates, separated by papulæ, the spinelets on which show a tendency to fall in lineal transverse series. On the abactinal area generally single papulæ occur between the plates.

The infero-marginal plates, which stand at the junction of the lateral and actinal areas, form a regular longitudinal series along the ray. Each plate bears an oblique series of three short, compressed, flaring, truncate, chisel-shaped spinelets, which radiate slightly apart, and form an oblique comb at the margin of the ray. Sometimes the truncate extremity of the spinelet is more or less crenulate or denticulate.

The adambulacral plates are contingent on the infero-marginal plates. Their armature consists of two moderately robust, equal spinelets, which stand one behind the other and radiate apart, forming two regular longitudinal series on each side of the furrow. The outer spine of the pair is usually more or less compressed and chisel-shaped, resembling the spinelets on the infero-marginal plates, but is not so broad; the inner spine, on the other hand, is generally subcylindrical, tapering, but rather obtusely pointed, and skin-covered. At the base of the inner series of spines, and rather high in the furrow, is a series of small forficiform pedicellariæ. Occasional isolated forficiform pedicellariæ are present between the outermost spines on the adambulacral plates and the comb of spines on the infero-marginal plates. And one or even more very large robust forficiform pedicellariæ may not infrequently be found in the narrow actinal interradial area behind the mouth-plates. Several large forficiform pedicellariæ with broad, curved, denticulated, interlocking extremities, may generally be found on the disk at the summit of the interbrachial arc.

The madreporiform body is small, and situated near the margin of the disk. It is grooved with comparatively few, coarse, convoluted striations, and its periphery, which is circular, is surrounded by a circlet of spinelets.

The ambulacral furrows are wide, and the tube-feet, which have a fleshy terminal disk, are quadriserially arranged.

Colour in alcohol, a bleached ashy grey or white, with occasional darker tints suggestive of a violet colour during life.

Locality.—Station 150. Between Kerguelen and Heard Islands. February 2, 1874. Lat. 52° 4′ 0″ S., long. 71° 22′ 0″ E. Depth 150 fathoms. Coarse gravel. Bottom temperature 35°·2 Fahr.; surface temperature 37°·5 Fahr.

Remarks.—This species is nearly allied to *Asterias* (*Smilasterias*) *scalprifera*, but is distinguished by the smaller habit, by the more compactly papillose character of the abactinal spinulation, and by the constant presence of only three spines in the oblique combs on the infero-marginal plates, and only two spines in the armature of the adambulacral plates, irrespective of the size of the example. I was at first inclined to think that this form might perhaps be the young stage of *Asterias* (*Smilasterias*) *scalprifera*, but the constancy of the characters above noted throughout the large series of examples collected appear to me, after a careful study, to warrant the recognition of *Asterias* (*Smilasterias*) *triremis* as a distinct species.

D. *Asterias ophidion* group: Subgenus Hydrasterias, nov.

14. *Asterias* (*Hydrasterias*) *ophidion*, n. sp. (Pl. XCIX. figs. 3 and 4; Pl. CIII. figs. 3 and 4).

Rays six. $R = 51$ mm.; $r = 7$ mm. $R > 7r$. Breadth of a ray at the base, 6·5 mm.; greatest breadth a little beyond the base, 7·5 mm.; breadth about midway between the base and the extremity, 5 mm.

Rays elongate, narrow, cylindrical, slightly inflated near the base, tapering gradually to the extremity, which is pointed and attenuate. Disk small, not higher than the base of the rays. Interbrachial arcs acutely angular, the rays appearing to be crushed together at the base.

The abactinal skeleton is composed of very narrow plates, which form a delicate wide-meshed network. The meshes are large, more or less quadrate in general form, and their major diameter is transverse in relation to the direction of the ray. A thin, band-like median radial line of plates may be indistinctly traced. The abactinal plates bear at wide intervals apart, short, isolated, delicate, tapering, skin-covered, microscopic spinelets. The spinelets upon the disk are much more robust than those on the rays and more closely placed. On the membrane which covers the meshes are borne numerous, but widely spaced, isolated, uniform, forcipiform pedicellariæ, the whole giving a wide-spaced granular appearance to the surface when viewed with the naked eye. Papulæ appear to be very few in number, small and difficult to distinguish, and probably not more than one is present in a mesh.

The armature of the adambulacral plates consists of two short, comparatively robust, skin-covered spinelets on each plate, forming a transverse pair, very close together and

slightly oblique. On the margin of the adambulacral furrow, at the base of the innermost adambulacral spine, may be one or more small sessile, triangular, forficiform pedicellariæ, not larger than the forcipiform pedicellariæ on the abactinal and lateral areas.

There is a longitudinal series of plates immediately external to the adambulacral plates, which bear a single spinelet a shade larger than those on the abactinal plates and numerous forcipiform pedicellariæ; the spinelets form a regular longitudinal row along the ray. At the base of the ray the innermost four or five spinelets may be longer than any of the others. Separated from these plates (? the representatives of infero-marginals) by a wide space occupied by numerous forcipiform pedicellariæ, a second but much less clearly defined longitudinal series of plates may be indistinctly traced, which are perhaps the representatives of supero-marginal plates, but differ in no way either in superficial character or armature from the abactinal plates generally, except that they sometimes bear two spinelets side by side.

The madreporiform body, which is large and placed near to the margin, is surrounded by a circlet of spinelets. The striations upon its surface are rather coarse and not much convoluted.

Colour in alcohol, a bleached yellowish white.

Locality.—Station 50. South of Halifax, Nova Scotia. May 21, 1873. Lat. 42° 8′ 0″ N., long. 63° 39′ 0″ W. Depth 1250 fathoms. Blue mud. Bottom temperature 38°·0 Fahr.; surface temperature 45°·0 Fahr.

Remarks.—*Asterias* (*Hydrasterias*) *ophidion* is distinguished by the six long worm-like rays; by the delicate, wide-meshed quadrate network of the abactinal area; by the few and isolated spinelets; by the isolated pedicellariæ; and by the diplacanthid armature of the adambulacral plates.

E. *Asterias mülleri* group: Subgenus Leptasterias.

15. *Asterias* (*Leptasterias*) *mülleri*, Sars, sp.

Asteracanthion Mülleri, Sars, 1844, Archiv f. Naturgesch., Jahrg. x., Bd. i. p. 169; Fauna Litt. Norvegiæ, 1846, 1ste Hefte, p. 56, tab. 8, figs. 38, 39; Oversigt af Norges Echinodermer, Christiania, 1861, p. 88.

Asterias Mülleri, Norman, 1865, Ann. and Mag. Nat. Hist., ser. 3, vol. xv. p. 127.

Leptasterias Mülleri, Verrill, 1866, Proceed. Boston Soc. Nat. Hist., vol. x. p. 350.

Localities.—"Porcupine" Expedition:

Station 67. East of the Shetland Islands. Lat. 60° 32′ 0″ N., long. 0° 29′ 0″ W. Depth 64 fathoms. Bottom temperature 9°·5 C.; surface temperature 11°·0 C.

Station 68. East of the Shetland Islands. Lat. 60° 23′ 0″ N., long. 0° 33′ 0″ E. Depth 75 fathoms. Bottom temperature 6°·7 C.; surface temperature 11°·4 C.

Station 82. In the Faeröe Channel. Lat. 60° 0′ 0″ N., long. 5° 13′ 0″ W. Depth 312 fathoms. Bottom temperature 5°·2 C.; surface temperature 11°·2 C.

"Knight Errant" Expedition :

Station 3. Off the Island of North Rona. August 3 and 4, 1880. Lat. 59° 12′ 0″ N., long. 5° 57′ 0″ W. Depth 53 fathoms.

"Triton" Expedition :

Station 5. In the Faeröe Channel. August 10, 1882. Lat. 60° 11′ 0″ to 60° 20′ 0″ N., long. 8° 15′ 0″ to 8° 8′ 0″ W. Depth 433 to 285 fathoms. Bottom temperature 43°·5 to 40°·8 Fahr.

16. *Asterias* (*Leptasterias*) *compta*, Stimpson.

Asterias compta, Stimpson, 1861, Proc. Boston Soc. Nat. Hist., vol. viii. p. 270.
Leptasterias compta, Verrill, 1866, Proc. Boston Soc. Nat. Hist., vol. x. p. 350.

Locality.—Station 49. South of Halifax, Nova Scotia. May 20, 1873. Lat. 43° 3′ 0″ N., long. 63° 39′ 0″ W. Depth 85 fathoms. Gravel, stones. Bottom temperature 35°·0 Fahr. ; surface temperature 40°·5 Fahr.

Remarks.—I have referred a series of examples from Station 49 to this species. The form appears to be very closely allied to *Asterias tenera*, but I have not seen a sufficient number of specimens of the latter species to warrant a more definite expression of opinion as to their specific relationship.

F. *Asterias tenuispina* group : Subgenus STOLASTERIAS, nov.

17. *Asterias* (*Stolasterias*) *gemmifera* (Valenciennes, M.S.), Perrier.

Asteracanthion gemmifer (Valenciennes, M.S.), Perrier, 1869, Ann. Sci. Nat., 5e Série, t. xii. p. 237, pl. i., figs. 12 *a*, ½*b*, *c*.
Asterias gemmifer, Perrier, 1875, Révis. Stell. Mus., p. 46 (Archives de Zool. expér., t. iv. p. 310).

Locality.—Off Kandavu, Fiji Islands. On the reefs.

18. *Asterias* (*Stolasterias*) *tenuispina*, Lamarck.

Asterias tenuispina, Lamarck, 1816, Hist. nat. anim. s. vert., t. ii. p. 561.
Asterias Savaresi, Delle Chiaje, 1825, Memorie sulla stor. e not. Anim. s. vert. Napoli, vol. ii. p. 357, tav. xviii. fig. 6.
Echinaster Doriæ, Filippi, 1859, Revue et Mag. de Zoologie, 2e Série, t. xi. p. 63.
Echinaster tribulus, Filippi, 1859, Revue et Mag. de Zoologie, 2e Série, t. xi. p. 64.
Asterias glacialis, Grube, 1840, Actin. Echin. u. Würmer d. Adriat. u. Mittelmeers, p. 23.
Asteracanthion tenuispinus, Müller and Troschel, 1842, System der Asteriden, p. 16.
? *Asterias atlantica*, Verrill, 1871 (1868), Trans. Conn. Acad. Arts and Sci., vol. i. part 2, p. 368.

Locality.—Off Bermuda. On the reefs.

19. *Asterias* (*Stolasterias*) *calamaria*, Gray.

Asterias calamaria, Gray, 1840, Ann. and Mag. Nat. Hist., vol. vi. p. 179.
Asteracanthion calamaria, Müller and Troschel, 1842, System der Asteriden, p. 19.

Coscinasterias muricata, Verrill, 1871 (1867), Trans. Conn. Acad. Arts and Sci., vol. i. part 2, p. 249.
Asteracanthion australis, Perrier, 1869, Ann. Sci. Nat., 5e Série, t. xii. p. 220.
Asterias Jehennesii (Valenciennes, M.S.), Perrier, 1875, Révis. Stell. Mus., p. 47 (Archives de Zool. expér., t. iv. p. 311).

Localities.—Off Port Jackson. Depth and conditions not recorded.

Station 162. Off East Moncœur Island, Bass Strait. April 2, 1874. Lat. 39° 10′ 30″ S., long. 146° 37′ 0″ E. Depth 38 fathoms. Sand and shells. Surface temperature 63°·2 Fahr.

20. *Asterias* (*Stolasterias*) *volsellata*, n. sp. (Pl. CVII. figs. 1–4).

Rays eleven. R = 128 mm.; r = 10 mm. R < 13 r. Breadth of a ray at the base, 7 mm; breadth about midway between the disk and the extremity, 5 mm.

Rays elongate and narrow, tapering gradually to the extremity, the outer part being very delicate and attenuate. Abactinal surface of the rays slightly arched and faintly carinate; lateral walls high and vertical. Disk small, depressed, and well defined, the rays readily becoming detached. Interbrachial arcs acute.

The skeletal plates of the rays, which are narrow and delicate, are disposed with great regularity. They form a median radial series, a supero-marginal series which bounds the abactinal area, and an infero-marginal series which is contingent on the adambulacral plates. Between these five regular longitudinal series of plates are transverse bars of similar plates at subequal distances apart which form large quadrangular meshes, covered with a thin delicate membrane. The plates in the longitudinal series, which stand at the place of junction with the transverse bars, may be more or less cruciform, and bear a single elongate and very delicate needle-like spine, the longest near the base of the ray measuring about 4 mm.; the spinelets are about 4 mm. apart. The base of the spine is invested with a short membranous sheath, which is surmounted by a thick, densely crowded wreath of forcipiform pedicellariæ, the spinelet appearing as if passing through a globular mass of these bodies. On the outer part of the ray the abactinal plates become very small and quite aborted in character, the transverse bars which stretch from side to side being frequently the most conspicuous, and then closely resemble the transverse bars of plates occurring in *Brisinga;* the wide intervening spaces covered only with semitransparent membrane enhance the striking similarity. At the base of the ray the membrane which covers the meshes is punctured with numerous small papulæ congregated in groups, several groups being present in each mesh. Several rather large, elongate, isolated forficiform pedicellariæ are borne upon the membrane, amongst and between the groups of papulæ. There are also a number of very large forficiform pedicellariæ, having the jaws broad, curved and expanded at the tips, which are armed with several large, interlocking denticles; these comparatively gigantic pedicellariæ are generally placed singly at or near the base of the large spinelets, and the frequency of this position leads to the supposition

that their presence is in relation to the encircling wreath of forcipiform pedicellariæ at the base of the spines.

The adambulacral plates are very small, and their armature consists of a single short, delicate, tapering spinelet about 1·5 mm. long, or a trifle more, the series of which forms a regular longitudinal line on each side of the furrow. At the base of these spines and quite within the furrow is an irregular and often interrupted series of small forficiform pedicellariæ, generally more or less pedunculated.

The ambulacral furrows are wide, and the tube-feet, which have a very small, button-like terminal disk, are biserial in arrangement at the base and on the outer part of the ray, but are crowded and assume an alternating quadriserial arrangement about the middle of the ray.

The actinostome is very wide, measuring about 11 mm. in diameter, and there is a broad exposed buccal membrane.

The madreporiform body, which is rather small and inconspicuous, is situated nearer the margin than midway between the centre and the margin, and its surface is marked with fine convoluted striations.

The anal aperture is large and excentric in position.

Colour in alcohol, a bleached ashy white.

Locality.—Near Zebu, Philippine Islands. January 19, 1875. Depth 95 fathoms.

Remarks.—The resemblance of this form to *Brisinga* at first glance is very striking. The small, well-defined, button-like disk, the long narrow and easily detachable rays, the simplicity of the skeletal framework, and the widely expanded actinostome at once recall that group of starfishes. On the other hand, the structural affinities of *Asterias* (*Stolasterias*) *volsellata* clearly point in the direction of *Asterias* (*Stolasterias*) *tenuispina*, *Asterias* (*Stolasterias*) *calamaria*, and their allies, and although there is much temptation to recognise the striking features of the external form above referred to by placing the species in a distinct genus, I do not after careful study feel justified in taking this step on the strength of the single example at my disposal.

Although I am quite disposed to think that the group of species of which *Asterias tenuispina* is the type will ultimately be separated as an independent genus, which may well be called *Stolasterias*, I prefer at present to treat them as I have done other groups considered in this Report, and to rank them provisionally only as a subgenus, until more is known of the anatomy of the various constituents of the present genus *Asterias*, and the partition can be undertaken on a sounder and more definite basis than is yet possible.

Apart altogether from these considerations, *Asterias* (*Stolasterias*) *volsellata* furnishes a highly interesting link between the Asteriidæ and Brisingidæ, and shows that the two families are not so widely separated as they were at one time considered to be. I am inclined to think that the Brisingidæ are the degenerate descendants of a not very remote ancestor, modified through the action of complete isolation.

21. *Asterias* (*Stolasterias*) *stichantha*, n. sp. (Pl. CVI. figs. 1–4).

Rays five. R = 158 mm.; r = 17 mm. R > 9 r. Breadth of a ray at the base, about 18 mm.

Rays elongate, broad and robust at the base, tapering gradually to a pointed extremity. Abactinal surface of the rays roundly convex and having a subcylindrical appearance when viewed from above. Disk small, slightly convex, but not higher than the rays. Interbrachial arcs acute.

The skeletal plates of the rays are disposed with great regularity, and those of the abactinal surface bear single uniform spinelets. Nine regular longitudinal series of equally spaced, isolated spinelets may be counted on the abactinal surface of the rays, the spinelets of the outermost series on each side being a shade larger than the others, and represent in my opinion a supero-marginal series. The median radial series is not different from the others. The spinelets, which are cylindrical, tapering, and pointed, measure from 2·5 to 3·5 mm. in length, and are surrounded at the base by one or two circlets of rather large, flattened, peculiarly blunt, skin-covered forcipiform pedicellariæ, which have to a certain extent the appearance of being appressed to a slightly convex elevation surrounding the base of the spine. Between adjacent wreaths is a space of naked membrane, and large isolated forficiform pedicellariæ with strong and coarsely denticulate interlocking extremities are present here and there. The papulæ are in small, compact, isolated groups, with seldom more than five or six in each, except upon the disk, where the number is rather greater. The infero-marginal plates bear two spinelets, which stand as an obliquely placed pair; these spinelets are a little longer than the supero-marginal series, very robust at the base and thickly skin-covered, and each bears on its outer side a small tuft of pedicellariæ similar to those above described. The small but distinct space of naked membrane between the supero-marginal and infero-marginal spines is occupied only by small isolated groups of papulæ and an occasional large forficiform pedicellaria. Between the infero-marginal plates and the adambulacral plates is a single series of large isolated papulæ, one standing between each pair of infero-marginal spines and near the base of the innermost spine of the pair.

The adambulacral plates are very small, and their armature consists of two rather long, equal, cylindrical, and slightly tapering spinelets which radiate slightly apart. At the base of the ray they measure from 3·5 to 4 mm. in length. Along the margin of the furrow, at the base of the innermost spines, are a number of large, elongate, pointed-jawed, forficiform pedicellariæ with long peduncles. There may be one to each alternate plate, but sometimes they occur more frequently.

The ambulacral furrows are very wide, and the tube-feet, which have small, fleshy, centrally invaginated terminal disks, are quadriserial in their arrangement throughout.

The madreporiform body, which is rather large and circular in outline, is situated about midway between the centre of the disk and the margin; its surface is marked

with numerous very fine striations, which radiate centrifugally, with considerable regularity.

Colour in alcohol, a bleached yellowish white; the spinelets white.

Locality.—Station 232. South of Yeddo, Japan. May 12, 1875. Lat. 35° 11′ 0″ N., long. 139° 28′ 0″ E. Depth 345 fathoms. Green mud. Bottom temperature 41°·1 Fahr.; surface temperature 64°·2 Fahr.

Remarks.—*Asterias* (*Stolasterias*) *stichantha* is a large and striking form, altogether unlike any other species in the genus. It may be at once distinguished by the isolated, equally spaced, basally-wreathed spinelets, arranged in numerous longitudinal series.

22. *Asterias* (*Stolasterias*) *eustyla*, n. sp. (Pl. CVI. figs. 5–8).

Rays five. R = 60 mm.; *r* = 7 mm. R > 8 *r*. Breadth of a ray near the base, 8 to 9 mm.

Rays elongate, comparatively robust, tapering slightly towards the extremity; about as high as broad, and subangular in section in consequence of the prominence of the supero-marginal and median radial series. Disk very small and indistinctly defined, not higher than the rays. Interbrachial arcs acute.

The abactinal surface of the rays is bounded by a supero-marginal series of plates on each side, each of which bears a single erect, rather robust, conical, pointed spinelet about 3 mm. in length, encircled at the base by a large, thick, semiglobular wreath of pedicellariæ, rendered more massive by the presence of membrane. The median abactinal line of the ray is occupied by a precisely similar longitudinal series of equal-sized spinelets with basal wreaths of pedicellariæ, and in the interspace between the median and supero-marginal series is a series—more or less interrupted—of exactly similar but rather smaller spinelets, with basal wreaths. Papulæ, which are large, delicate, and bag-like when extended, occur in the narrow space between the wreaths of pedicellariæ, and occupy also the spaces where the intermediate series is interrupted. The lateral wall or space between the supero-marginal series and the infero-marginal series is occupied only by large papulæ, and these are either isolated or in indistinct groups of two or three. The infero-marginal plates form a conspicuous and regular longitudinal series, and each bears three spines arranged in an oblique series, which stands at an angle of about 45 degrees to the direction of the ray. These spines are robust at the base, flattened at the tip, and either truncate or obtusely rounded. The outermost spine is larger and longer than any of the spines above noticed on the abactinal surface, the median spine is rather smaller, and the innermost spine, which is very near the adambulacral plates, is not more than half the size of the outermost spine. On the outer side of the outermost spine is a large semiglobular tuft of pedicellariæ, similar to those above described, but it does not encircle the spine as a wreath. Near the base of the innermost spine is a single large papula, and the series of these separates the infero-marginal spines from the adambulacral plates.

The adambulacral plates are small, and their armature consists of two short, equal, slightly flattened, slightly tapering and obtusely tipped spinelets, closely placed. I have not detected the presence of any forficiform pedicellariæ on the actinal surface of this species.

The adambulacral furrows are narrow, and almost arched over by the armature of the adambulacral plates when contracted. The tube-feet are crowded, and disposed in quadriserial arrangement.

The madreporiform body, which is small, and almost obscured by a surrounding vesiculated membrane, is placed very near the margin.

Colour in alcohol, a bleached yellowish or warm light brownish white.

Locality.—Off Nightingale Island, Tristan da Cunha group. Depth 100 to 150 fathoms.

Remarks.—This species resembles *Asterias* (*Stolasterias*) *tenuispina* in general character and appearance, but differs in such essential details that I can entertain no doubt as to its specific distinction, although I feel great reluctance in establishing a new species in such a difficult genus on the single example which is unfortunately all that was procured. *Asterias* (*Stolasterias*) *eustyla* is distinguished from the other members of the *Asterias tenuispina* group (the subgenus *Stolasterias*) by its five rays, by the oblique series of three spines on the infero-marginal plates, by the presence of two spines in the armature of the adambulacral plates, and by the interrupted but definite intermediate series of spinelets between the median abactinal and supero-marginal series.

Asterias mollis of Hutton is probably nearly allied, but differs in the disposition of the intermediate abactinal spines, in the size and propinquity of the spinelets generally, in the character of the wreaths of pedicellariæ at their bases, and in the different form of the rays.

23. *Asterias* (*Stolasterias*) *glacialis*, O. F. Müller.

Asterias glacialis, O. F. Müller, 1776, Zool. Dan. Prodr., p. 234.
Asterias spinosa, Pennant, 1777, British Zoology, vol. iv. p. 62.
Asterias angulosa, O. F. Müller, 1788, Zool. Dan., vol. ii. p. 1, tab. xli.
Asterias echinophora, Delle Chiaje, 1825, Memorie sulla stor. e not. Anim. s. vert. Napoli, vol. ii. p. 356, tav. xviii. fig. 5.
Stellonia glacialis, Nardo, 1834, De Asteriis, Oken's Isis, p. 716.
Stellonia angulosa, Agassiz, 1835, Mém. Soc. Sci. Nat. Neuchatel, t. i. p. 192.
Stellonia webbiana, d'Orbigny, 1839, in Webb and Berthelot, Hist. Nat. Iles Canaries, t. ii., 2e partie, Zoologie, p. 148, Echin., pl. ii. figs. 8–13.
Uraster glacialis, Forbes, 1841, Hist. Brit. Starfishes, p. 78.
Asteracanthion glacialis, Müller and Troschel, 1842, System der Asteriden, p. 14.
Asteracanthion webbianum, Dujardin and Hupé, 1862, Hist. Nat. Zooph. Échin. (Suites à Buffon), p. 340.
Asterias madeirensis, Stimpson, 1862, Proc. Boston Soc. Nat. Hist., vol. viii. p. 263.
Marthasterias foliacea, Jullien, 1878, Bull. Soc. Zool. France, p. 141.

Locality.—Off St. Vincent, Cape Verde Islands. Depth and conditions not stated.

24. *Asterias* (*Stolasterias*) *africana* (Müller and Troschel), Perrier.

Asteracanthion africanus, Müller and Troschel, 1842, System der Asteriden, p. 15.
Asterias africana, Perrier, 1875, Révis. Stell. Mus., p. 62 (Archives de Zool. expér., t. iv. p. 326).

Locality.—Simon's Bay, Cape of Good Hope. Depth 5 to 20 fathoms. Also shallow water.

Genus *Calvasterias*, Perrier.

Calvasterias, Perrier, Révis. Stell. Mus., p. 84 (Archives de Zool. expér., 1875, t. iv. p. 348).

This well-defined genus, apart from its structural peculiarities, is remarkable for the puffy skin and clammy character which it possesses in common with so many of the Antarctic asterids. The examples of the two hitherto known species preserved in the British Museum are from this geographical area; but *Calvasterias asterinoides* is stated by M. Perrier to occur also in Torres Strait.

Chorology of the Genus Calvasterias.

α. *Geographical distribution:*—

Atlantic: Two species between the parallels of 40° and 60° S.
Calvasterias asterinoides and **Calvasterias stolidota*, from the Falkland Islands, the former extending to Torres Strait (*fide* Perrier), and the latter to the Messier Channel, between the west coast of Chili and Wellington Island.

Pacific: One species between the parallels of 40° and 60° S.
**Calvasterias stolidota*, in the Messier Channel, between the west coast of Chili and Wellington Island, and extending to the Falkland Islands.

Eastern Archipelago: One species between the parallels of 10° N. and 15° S.
Calvasterias asterinoides, from Torres Strait (*fide* Perrier, stated to have been dredged by MM. Hombron and Jacquinot in 1841), and extending to the Falkland Islands.

β. *Bathymetrical range:* Imperfectly known, probably all from the Littoral zone.
Calvasterias stolidota, from 5 to 10 fathoms off the Falkland Islands.

γ. *Nature of the Sea-bottom: Calvasterias stolidota* on sand, gravel; other species not recorded.

The species collected by the Challenger is indicated by an asterisk in the above list.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Calvasterias antipodum . .	?	...	...
Calvasterias asterinoides . .	S. Atlantic and Eastern Archipelago.	...	...
Calvasterias stolidota . .	S. Atlantic and S. Pacific.	5 to 10	Sand, gravel.

1. *Calvasterias stolidota*, n. sp. (Pl. CI. figs. 3 and 4; Pl. CIII. figs. 11 and 12).

Rays five. R = 44 mm.; r = 11 mm. R = 4 r. Breadth of a ray at the base, 13·5 mm.

Rays rather short, tapering slightly from the base to the extremity, which is obtusely pointed. Abactinal surface convex and arched, the lateral wall being nearly vertical. Actinal surface plane, forming an angular junction with the lateral wall. In the present condition of the specimen the rays are curved downward. Interbrachial arcs acute. A more or less clearly defined channel occurs upon the disk in the wrinkles of the membrane in the median interradial lines.

The whole abactinal surface is covered with a somewhat puffy membrane, very clammy and unpleasant to the touch, marked with constrictions or wrinkles which pass between the papular areas. Midway on the ray in the median line the broad tips of a few obtuse but isolated spinelets may be seen protruding through the membrane, but they are scarcely noticeable. The papulæ are arranged in compact little groups of about five or six in each; the groups are well spaced and fall into six more or less regular longitudinal lines. A few small pedicellariæ may be present in the neighbourhood of the papulæ of the outer two rows on each side.

The armature of the adambulacral plates consists of a single robust, cylindrical, obtusely-tipped spinelet, the series of which forms a regular longitudinal line along the ray. At the base of these spines, on the margin of the ambulacral furrow, are a few short, robust, forficiform pedicellariæ. The actinal plates, which form the margin of the ray, and are probably the representatives of infero-marginal plates, bear an oblique series of two or three equal, short, robust, obtuse spinelets. In the interspace between these plates and the adambulacral plates, which is narrow, are large isolated papulæ, and between these may be a spinelet intermediate in size between those on the adambulacral plates and the marginal plates, and these form an irregular series which, from their position, might at first sight be counted with either one series or the other; they are found, however, on examination to be not attached to the adambulacral plates. Above the infero-marginal plates just described, in the vertical wall of the ray, is a rather wide

space occupied by groups of large papulæ and numerous pedicellariæ, which is bounded superiorly by a single regular longitudinal row of short, robust, obtuse, equally spaced spinelets borne on the representatives of the supero-marginal plates; and above these, on the margin of the abactinal area, are numerous pedicellariæ.

The madreporiform body, which is small, sunken, and almost hidden by the encroachment of the puffy membrane, is situated about midway between the centre of the disk and the margin, and the tips of several obtuse, robust spinelets may be seen round the circumference.

The ambulacral furrows are wide, and the tube-feet, which have a quadriserial arrangement, are crowded, and have fleshy terminal disks with invaginated centres.

Colour in alcohol, an ashy grey.

Young Phase.—There is a small example from Port William, Falkland Islands, which I take to be the young of this species. The dimensions are R = 15·5 mm. ; r = 5·25 mm. The rays are well defined and of nearly uniform breadth from the base to the extremity. There are not more than two or occasionally three spines in the oblique series on the infero-marginal plates, and these come close up to the adambulacral plates. The intermediate irregular series of spines noticed in the adult are not present in the young form, although when three spinelets are present in the oblique series on the infero-marginal plates the innermost one strikingly simulates in its position the intermediate spines referred to. The supero-marginal series of spines is present, and pedicellariæ are numerous and relatively large.

Localities.—In the Messier Channel, between Wellington Island and the west coast of Chili. January 1876. Exact position, depth, and conditions not recorded.

Station 315. Port William, Falkland Islands. January 26, 1876. Lat. 51° 40′ 0″ S., long. 57° 50′ 0″ W. Depth 5 to 10 fathoms. Sand, gravel. Surface temperature 50°·0 Fahr.

Remarks.—This species resembles *Calvasterias antipodum* in the length of the rays and the general form, but differs by the absence of the crowded median radial line of spinelets ("scale-like processes" of Bell[1]), and by the presence of the regular and well-developed series of supero-marginal spines, which are wanting in *Calvasterias antipodum*. The arrangement of the spines on the infero-marginal plates and the presence of numerous pedicellariæ also serve to characterise *Calvasterias stolidota*. The general form and the majority of the above-mentioned points of structure at once distinguish the species from *Calvasterias asterinoides*. The young form, which is smaller in size than *Calvasterias asterinoides*, is already distinguished by the well-developed rays, and has a facies altogether different from that *Asterina*-shaped species.

[1] *Proc. Zool. Soc. Lond.*, 1882, p. 122.

Family Brisingidæ, Sars, 1875.

The family Brisingidæ was established by G. O. Sars[1] for the reception of the single genus *Brisinga*, of which at that time two species only were known, *Brisinga endecacnemos* of Asbjørnsen and *Brisinga coronata* of Sars. In 1878, Viguier[2] included in the same family the genera *Labidiaster* and *Pedicellaster*. In 1883, De Loriol[3] added the genus *Brisingaster*. In 1884, Perrier[4] added the genus *Hymenodiscus*, but removed *Pedicellaster* to an independent family. In the following year Perrier[5] also added the genera *Freyella* and *Odinia*, which may to a certain extent be considered as dismemberments of *Brisinga*, since species of both genera had primarily been described as *Brisinga*. Perrier further added at the same time the new genus *Coronaster*, and replaced the genus *Pedicellaster* in the family Brisingidæ. With this latter step I am unable to agree. In 1884, Studer[6] added the new genus *Gymnobrisinga*, and confirmed on anatomical grounds the classification of *Labidiaster* with the Brisingidæ, but expressed a doubt, modified however by the subsequent discovery of an eight-rayed form from South Georgia, as to the correctness of placing *Pedicellaster* in the same family.

As to whether the differences between *Hymenodiscus* and *Gymnobrisinga* are of generic value, and as to whether these forms are generically distinct from *Brisinga*, I am unable to express an opinion, as I have not seen examples of either of the forms. The descriptions alone are insufficient to settle the question, and lead to the inference that the alliance of the forms mentioned is of the closest description and that all are perhaps congeneric.

I am also in doubt as to whether *Brisingaster* can justly be separated from *Brisinga*. From the admirable description and figures given by M. de Loriol, as well as from the examination of a dried specimen, I am inclined to think that the differences are not sufficient to warrant the establishment of an independent genus, but I have refrained from directly placing *Brisingaster* as a synonym of *Brisinga*, as I have not had the opportunity of examining alcoholic examples of the well-defined Mauritius species.

So far as I can judge from the description alone I am unable to recognise in *Coronaster* a member of the family Brisingidæ. I venture to think that the genus in question will prove to be much more nearly related to the Asteriidæ.

On the grounds above stated I have not included the four genera, *Brisingaster*, *Gymnobrisinga*, *Hymenodiscus*, and *Coronaster*, in the subjoined synopsis of the genera constituting the family Brisingidæ.

[1] On some remarkable forms of animal life from the great depths off the Norwegian coast. Part II. University Program, Christiania, 1875, pp. 100, 101.

[2] *Archives de Zool. expér.*, 1878, t. vii. pp. 93, 119.

[3] *Mém. Soc. Phys. et Hist. Nat. Genève*, 1883, t. xxviii. No. 8, p. 55.

[4] *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1884, t. vi. pp. 166, 189.

[5] *Ann. Sci. Nat.* (Zool.), 1885, t. xix. Art. No. 8, pp. 5, 9.

[6] *Anhang z. d. Abhandl. d. k. preuss. Akad. d. Wiss. Berlin*, vom Jahre 1884, p. 13.

I have added a new genus, *Colpaster*, for the reception of a form characterised by the presence of an externally conspicuous azygos interradial plate separating the first pair of adambulacral plates, and further differing from *Freyella* in the development of the armature of the mouth-plates and the adambulacral plates.

Since the discovery of *Brisinga endecacnemos* in 1853, perhaps no other Asterid has been looked upon with so much interest by naturalists, or has given rise to a greater amount of speculation as to its antiquity and structural relations. The Brisingidæ have been stated to represent the most primitive type of living starfishes, and to present a closer approach to the Ophiuroidea than any other form. I consider that these views are entirely unwarranted. It is now generally admitted by all workers at the group that the Brisingidæ are most nearly related to the Asteriidæ, Heliasteridæ, and Echinasteridæ. Taking *Asterias* as a comparatively well-known and central form, it may be asked, Does the plan of structure of this genus represent the most archaic or the most primitive type of Asterid structure with which we are acquainted? and, Does it present the nearest approach to the plan of Ophiuroid structure? The reply to these questions would, I think, be unhesitatingly in the negative. Supposing for the sake of argument that the Brisingidæ are older than the Asteriidæ, May *Asterias* be considered to represent even a penultimate stage? I think not, and in my opinion such an assumption would be entirely without foundation. Palæontological evidence certainly does not support it, and the embryological history of *Asterias* points unequivocally to a phanerozonate ancestry. In my opinion the Brisingidæ are true cryptozonate Asterids, very nearly related to the Asteriidæ, Pedicellasteridæ, Heliasteridæ, and Echinasteridæ, and probably derived from a common ancestor, the divergence of form and the peculiarities of structure now exhibited by *Brisinga* being the result of modification produced by the extreme isolation and the exigencies of the abyssal depths in which the family has existed. We know too little of the embryology of *Brisinga* and its allies to speculate further at present on its antiquity or relations, and to say more than is suggested above in our present state of knowledge would be, in my opinion, to ignore altogether the evidence of palæontology and of the embryological development of those forms with which we are acquainted.

Synopsis of the Genera included in the Family Brisingidæ.

A. Disk large. Rays very numerous. Abactinal plating reticulate. Forficiform and forcipiform pedicellariæ present . . . . . *Labidiaster.*

B. Disk small. Rays not very numerous (six to seventeen in number). Abactinal plating when present not reticulate. No forficiform pedicellariæ, forcipiform pedicellariæ very numerous.

a. Abactinal plating consisting of narrow widely-spaced transverse bands or ridges limited to the basal portion of the ray.

a. Intermediate abactinal membrane punctured by papulæ . . . *Odinia.*

b. No papulæ in the intermediate abactinal membrane . . . . . *Brisinga.*

| *b.* Abactinal plating of the disk and basal portion of the rays consisting of scale-like imbricating plates. No papulæ.

a. No azygos interradial plate separating the first pair of adambulacral plates . . . . . *Freyella.*

b. An azygos interradial plate separating the first pair of adambulacral plates . . . . . *Colpaster.*

Genus *Labidiaster*, Lütken.

Labidiaster, Lütken, Videnskab. Medd. naturh. Foren. i Kjøbenhavn, 1871, p. 289.

The genus *Labidiaster* was considered by Lütken as most nearly allied to *Pedicellaster*. It was placed by Perrier[1] in 1878 in the family Asteriidæ, but was subsequently ranked by Viguier[2] along with *Brisinga* and *Pedicellaster* in the family Brisingidæ. The recent researches of Studer[3] have fully confirmed the justice of placing *Labidiaster* in that family. Hitherto the genus was supposed to be confined to the southern point of the American continent; its range is now, however, considerably extended by its discovery in the Southern Ocean and in the Arafura Sea. The occurrence of this and other Antarctic species in the last-mentioned region is highly remarkable, and would have been almost suggestive of an error in labelling if one case only had occurred.

Chorology of the Genus Labidiaster.

a. Geographical distribution:—

Atlantic: One species between the parallels of 30° and 55° S.

Labidiaster radiosus, off the eastern coast of Patagonia, passing as far north as the mouth of the Rio de la Plata (*fide* Kinberg), also in the Strait of Magellan, and extending to the Pacific side in the Trinidad Channel. (This may, perhaps, *fide* Bell,[4] be a distinct species, for which, if necessary, he proposes the name *Labidiaster luetkeni*.)

Southern Ocean: One species between the parallels of 45° and 55° S.

Labidiaster annulatus, off Kerguelen Island and Heard Island, and extending into the Arafura Sea.

Eastern Archipelago: One species between the parallels of 0° and 10° S.

Labidiaster annulatus, from north-west of the Arrou Islands,

[1] *Nouv. Archives Mus. Hist. Nat.*, 2e Série, 1878, t. i. pp. 10, 44, 76.

[2] *Archives de Zool. expér.*, 1878, t. vii. p. 119.

[3] *Anhang z. d. Abhandl. d. k. preuss. Akad. d. Wiss. Berlin*, vom Jahre 1884, p. 14.

[4] *Proc. Zool. Soc. Lond.*, 1881, p. 94.

and extending into the Southern Ocean in the neighbourhood of Kerguelen and Heard Islands.

Pacific: One species between the parallels of 45° and 55° S.

Labidiaster radiosus, from the Trinidad Channel, west coast of Patagonia, and extending through the Strait of Magellan to the east coast of Patagonia and Rio de la Plata (*fide* Kinberg).

β. *Bathymetrical range:* 30 to 800 fathoms.

Greatest range of one species: *Labidiaster annulatus*, 75 to 800 fathoms.

γ. *Nature of the Sea-bottom*: *Labidiaster radiosus* on sand; *Labidiaster annulatus* on Volcanic mud, Green mud, and coarse gravel.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Labidiaster annulatus . .	Southern Ocean and Eastern Archipelago.	75 to 800	Volcanic mud, Green mud, coarse gravel.
Labidiaster radiosus . .	Atlantic and Pacific.	30 to 63	Sand.

1. *Labidiaster radiosus* (Lovén), Lütken (Pl. CVIII. fig. 2).

Labidiaster radiosus (Lovén, M.S.), Lütken, 1871, Videnskab. Medd. naturh. Foren. i Kjøbenhavn, p. 293.

Locality.—Station 313. Near the Atlantic entrance to the Strait of Magellan. January 20, 1876. Lat. 52° 20′ 0″ S., long. 67° 39′ 0″ W. Depth 55 fathoms. Sand. Bottom temperature 47°·8 Fahr.; surface temperature 48°·2 Fahr.

Remarks.—In addition to the excellent description given by Lütken, this species has recently been exhaustively described by Studer,[1] who also made a careful examination of its anatomical structure, and illustrated a number of the more important details. I have therefore limited myself to a single figure of *Labidiaster radiosus*, which I have given for the purpose of comparison with the new species.

2. *Labidiaster annulatus*, n. sp. (Pl. CVIII. fig. 1).

Rays forty to forty-five. $R = 165$ to 190 mm.; $r = 33$ mm. $R > 5\,r$. Breadth of a ray at about 20 mm. from the disk, 6 to 7 mm.

Rays elongate, delicate, and cylindrical; constricted at the base, where they are closely crushed together, then gradually swelling slightly, the ray being broadest at about the

[1] *Anhang z. d. Abhandl. d. k. preuss. Akad. d. Wiss. Berlin*, vom Jahre 1884, p. 14, Taf. ii., iii.

end of the inner third or fourth, beyond which it gradually tapers to an attenuate extremity. The interbrachial arcs are a mere close cleft, in consequence of the crowding of the rays at the base.

The disk is large and circular, subplane, and capable of slight inflation, slightly elevated above the base of the rays, and more or less distinctly defined. The abactinal surface is beset with small imbricating plates forming a wide meshed network, the whole being covered with a membrane which is punctured in the interspaces by numerous papulæ. The plates bear small uniform spinelets, scarcely, if at all, larger than those upon the rays, and here and there, widely spaced, are large, triangular, forficiform pedicellariæ; much smaller, elongate, forficiform pedicellariæ are more numerous.

The abactinal surface of the ray on the basal portion is similarly beset with small imbricating plates, which form a wide meshed network, the meshes being more or less quadrangular. The longitudinally directed series of plates are, however, confined strictly to the abactinal surface, and do not occur on the lateral walls of the ray, where widely spaced, transverse series only are found, one opposite about every third adambulacral plate. The lowest plate, which abuts on the adambulacral plates, is probably the representative of an infero-marginal plate, and bears a single small, sharply pointed spinelet. The abactinal plates do not extend far beyond the ovarial region of the ray, and the transverse bands are then probably represented only by an aborted rudiment of the infero-marginal plate, bearing, however, a fully developed spine, which may extend for two-thirds of the length of the ray or more. The abactinal plates bear small, isolated, sharply pointed spinelets, similar to those upon the disk, and the membrane which covers the interspaces is punctured by numerous papulæ. A number of small forficiform pedicellariæ occur on the membrane, and great numbers of comparatively large forcipiform pedicellariæ are present, borne on a roll or sacculus of membrane, and disposed as a thick transverse ruff or annulus, isolated and well spaced from its neighbours, encircling the ray, and extending on each side to the adambulacral plates.

The ambulacral furrow occupies the greater part of the actinal surface of the ray, measuring about 4 mm. at a part where the whole ray is 6·25 mm. The adambulacral plates are short and narrow, inclined at a considerable angle aborally, and are separated by a space nearly equal to their length occupied by muscular ligament. Their armature consists of two short, cylindrical, tapering, sharply pointed spines, which diverge slightly, one towards the furrow, the other outwardly. The bases of the two spinelets together occupy the whole of the actinal surface of the small adambulacral plates. On the outer side of the outer spine is a rather elongate tuft of small forcipiform pedicellariæ, and within the margin of the furrow and at the base of the inner spine may be one or occasionally two very small forficiform pedicellariæ. The ambulacral tube-feet, which are robust and crowded, are biserial in their arrangement, and have a small, button-like, centrally invaginated terminal disk.

The actinostome is large and wide, its diameter being about 38 mm. in the specimen described. The buccal membrane, which is of broad expanse, is thick and leathery, and is marked with very fine radiating lines of low, crowded, villiform papillæ.

The madreporiform body is large and prominent, often slightly elevated above the general surface of the disk, and is situated close to the margin. Its outline is irregularly circular, 7·25 mm. in diameter, and is surrounded by a series of closely placed, small, pointed spinelets, about forty-five in number. Its surface is marked with very fine, much convoluted striations, which show a regular centrifugal radiation on the outer part.

Colour in alcohol, a dirty ashy grey.

Localities.—Station 149H. Off Cumberland Bay, Kerguelen Island. January 29, 1874. Depth 127 fathoms. Volcanic mud.

Station 150. Between Kerguelen Island and Heard Island. February 2, 1874. Lat. 52° 4′ 0″ S., long. 71° 22′ 0″ E. Depth 150 fathoms. Coarse gravel. Bottom temperature 35°·2 Fahr.; surface temperature 37°·5 Fahr.

Station 151. Off Heard Island. February 7, 1874. Lat. 52° 59′ 30″ S., long. 73° 33′ 30″ E. Depth 75 fathoms. Volcanic mud. Surface temperature 36°·2 Fahr.

Station 191. In the Arafura Sea, north-west of the Arrou Islands. September 23, 1874. Lat. 5° 41′ 0″ S., long. 134° 4′ 30″ E. Depth 800 fathoms. Green mud. Bottom temperature 39°·5 Fahr.; surface temperature 82°·2 Fahr.

Remarks.—This species may be distinguished from its near ally, *Labidiaster radiosus*, by the more numerous and comparatively more slender rays, by the uniformity in the size of the spinelets on the disk and at the base of the rays, and by the tufts of forcipiform pedicellariæ upon the rays forming a thicker and more complete annulus. Although the verbal account of these differences may lead to the inference that they are comparatively insignificant, they produce a very distinct facies, as may be seen on referring to Pl. CVIII. I am unable to detect any difference worthy of note between a small example from Station 191 and those from the neighbourhood of Kerguelen and Heard Islands. I have previously drawn attention to the remarkable occurrence of Antarctic forms at this station.

Genus *Odinia*, Perrier.

Odinia, Perrier, Ann. Sci. Nat. (Zool.), 1885, t. xix. Art. No. 8, p. 9.]

The establishment of *Odinia* as a genus distinct from *Brisinga* is due to M. Perrier, who pointed out that the more highly developed plating of the disk and basal portion of the rays, and the presence of papulæ, which characterise the species he proposed to separate, were structural details of sufficient importance to place the forms in a distinct genus. With these views I concur, and judging from the form I have studied, I consider that the shortness of the adambulacral plates, and probably the character of the mouth-

plates, may also be added as differential characters of primary importance; and further, as a secondary character, the disposition of the pedicellariæ is worthy of attention.

The intermediate character of *Odinia*, from a morphological point of view, between *Labidiaster* on the one hand and *Brisinga* and *Freyella* on the other, is striking and highly remarkable.

The species of *Odinia* described by Perrier were all dredged off the coast of Morocco. The species now described from the Faeröe Channel appears to have been confounded by Sir Wyville Thomson with *Brisinga coronata*, and was one of the first deep-sea novelties dredged by the "Lightning" in 1868.

Chorology of the Genus Odinia.

α. Geographical distribution:—

Atlantic: Four species between the parallels of 20° and 65° N.

Odinia pandina, from the Faeröe Channel. *Odinia semicoronata*, *Odinia robusta*, and *Odinia elegans*, off the coast of Morocco.

β. Bathymetrical range: 440 to 784 fathoms.

γ. Nature of the Sea-bottom: Unknown.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Odinia elegans . . .	Atlantic.	482 to 784	... ...
Odinia pandina . . .	Atlantic.	440 to 500	... ...
Odinia robusta . . .	Atlantic.	482 to 784	... ...
Odinia semicoronata . .	Atlantic.	577 to 784	... ...

1. *Odinia pandina*, n. sp. (Pl. CIX. figs. 1–5).

Brisinga coronata (*pars*), Wyville Thomson, 1873, The Depths of the Sea, p. 66, fig. 5.

Rays thirteen to eighteen. R = 215 mm.; r = 14 to 15 mm. R = 15 r approximately. Breadth of a ray at the base, 6·5 mm.; at the widest part of the ovarial expansion, 12 to 13 mm.; midway along the ray, about 7·5 mm.

Rays very elongate and comparatively robust for the family, narrow at the base, but swelling gradually and quickly into a large ovarial inflation, the tumidity of which is greater abactinally than laterally, and tapers off rather abruptly, terminating at about 48

mm. from the base. Beyond this the ray has a flattened or subdepressed appearance, the abactinal surface being convex, with a broad and somewhat indistinct median carination, the breadth being greater than the height.

The disk is small and button-like in form, the abactinal surface being convex, flattened centrally, and gradually rounded at the margin down to the base of the rays. The abactinal surface is beset with robust imbricating plates, between which are interspaces punctured by two or three papulæ. The plates are irregularly convex abactinally, and each bears two or three short, moderately robust, tapering, pointed spinelets about 2 mm. in length, which are near together at their bases, but radiate slightly apart, giving a decidedly echinulate appearance to the abactinal surface. The spinelets appear to be naked, and I have detected no pedicellariæ upon the disk. The papulæ are delicate, elongate, and vermiform. The ovarial region at the base of the rays is covered with a thick coriaceous skin, underlaid with small imbricating calcareous plates and punctured by numerous widely spaced, generally distributed papulæ. The outer half, or even outer two-thirds, of the ovarial region is traversed by bands of small prominent imbricating plates, which bear isolated, robust, conical spinelets 2 to 3 mm. in length. The bands are about 5 mm. apart, and the ovarial region has consequently the appearance of being encompassed by five or six echinulate rings; on the actinal surface of the inner third of the ovarial region the plating is more compact and irregular, and the spinelets are irregularly distributed, but do not occur on the lateral wall of the ray. On some of these spines are traces of a membranous sheath with closely crowded small pedicellariæ. The membrane between the echinulate rings is perfectly smooth and bears no pedicellariæ or tegumentary spinelets. Beyond the ovarial region the abactinal surface of the ray is covered with a thin semi-transparent membrane, and the transverse rings are represented only by short lateral calcareous ridges, the component plates appearing to be more or less ankylosed, upon which are borne from four to six rather long spinelets invested with thick membranous sheaths, crowded with numerous microscopic pedicellariæ. The spinelets in the middle of a series are generally slightly longer than the others, and may measure from 6 to 8 mm. in length; the uppermost spinelet is generally much less, and the smallest of the series. The lowest spinelet springs from a plate abutting on the adambulacral plates, and is the representative of the lateral or infero-marginal spine. It may measure 7 mm. in length, but is often less. The delicate membrane which covers the abactinal surface of the ray bears small round or irregular patches or sacculi crowded with microscopic pedicellariæ, the patches, though isolated, being numerous and quite irregular in their disposition. There is no tendency whatever towards the formation of the elongate, saddle-like, saccular bands which occur in *Brisinga* generally.

The ambulacral furrow is wide, measuring about 4 mm. at a part where the breadth of the ray is 8 mm. The adambulacral plates, which form a narrow well-rounded margin to the furrow, are very short, only about 1 mm. in length, distinctly but not widely

separated, and with the interspace filled in with ligament. Their armature consists of a single large spine which stands perpendicularly, and is articulated on a tubercular elevation occupying the whole of the actinal surface of the plate. A spine near the base of the ray about midway along the ovarial inflation measures 4·5 mm. in length, is broad and robust at the base, tapers to the middle of the shaft, and then expands gradually into a flaring and compressed extremity, which is truncate and chisel-shaped. As they recede from the base of the ray, after passing the ovarial region, the breadth of the tip of the spine diminishes, and the chisel-like character is almost, if not quite, lost midway along the ray, where the spines still measure 4·5 mm., but are much more delicate. Traces of a membranous sheath with crowded microscopic pedicellariæ are present on the outer side of a great number of these spinelets, but as to whether the spine was entirely invested I am unable to say.

The actinostome is wide, its diameter being 15 mm. in a disk measuring 29 to 30 mm. The buccal membrane is thick and plicate, becoming papillate at the mouth-margin. The mouth-plates, as well as the succeeding pair of adambulacral plates, which are apparently ankylosed, may be placed more or less obliquely or even perpendicularly and form a vertical margin to the actinostome. They are deeply excavated by the first pair of tube-feet, and this character is emphasised by the fact that lateral extensions proceed towards the adjacent pair and entirely bar the actinostomial entrance of the ambulacral furrow.

The free margin of each plate which abuts on the buccal membrane is very slightly curved, and bears two or three short, robust, skin-covered mouth-spines, somewhat dog-tooth shaped, the outer two radiating away from the innermost one towards the furrow, and touching or interlocking with the corresponding spines of the adjacent mouth-angle, barring the entrance to the ambulacral furrow. One or two small isolated pedicellariæ may be present on these spines. Near the outer extremity of each plate is a single small, conical, skin-covered spinelet, which is directed over the furrow and separates the first and second pair of ambulacral tube-feet. No other spinelets are present on the mouth-plates. The width of the united pair of plates midway between their extremities is very narrow, and is less than the diameter of the adjacent tube-foot.

The ambulacral tube-feet have large, centrally invaginated, terminal disks.

The madreporiform body, which is convex and prominent, is situated at the extreme margin of the disk. Its surface is marked with fine, convoluted striations, rather widely spaced.

Colour in alcohol, a bleached yellowish white, with a slight pinkish shade on the side of the ovarial regions.

Localities.—"Lightning" Expedition:

Station 7. In the Faeröe Channel. September 3, 1868. Lat. 60° 7′ 0″ N., long. 5° 21′ 0″ W. Depth 500 fathoms. Bottom temperature 1°·1 C.; surface temperature 10°·5 C.

"Porcupine" Expedition :

Station 51, 1869. In the Faeröe Channel. Lat. 60° 6′ 0″ N., long. 8° 14′ 0″ W. Depth 440 fathoms. Bottom temperature 5°·5 C. ; surface temperature 10°·9 C.

Other examples of *Odinia pandina* were also obtained during the "Porcupine" dredgings, but unfortunately they are without record of station or locality.

Remarks.—This handsome form was confounded by Sir Wyville Thomson with *Brisinga coronata*, the figure which he gives under that name in The Depths of the Sea (fig. 5, p. 67) being without doubt the Asterid above described. In the specimen preserved, all the rays, excepting several of the small recurved ones, are now separated from the disk; but notwithstanding this, I feel little or no hesitation in believing that the example before me is the one from which the drawing for the woodcut was made. The general form, the character of the spinulation of the ovarial regions, the irregularly disposed sacculi with crowded pedicellariæ upon the rays, the vertical lateral series of spinelets, and the large single actinal spinelets on the adambulacral plates, are all faithfully represented ; if to these characters be added the presence of papulæ, the shortness of the adambulacral plates, the strongly spinulate disk (which is not sufficiently shown in the woodcut), and the form and armature of the mouth-plates, we have a congeries of characters readily distinguishing *Odinia pandina* from *Brisinga coronata*.

Genus *Brisinga*, Asbjørnsen.

Brisinga, Asbjørnsen, Fauna Litt. Norvegiæ, 1856, Andet Hefte, p. 95.

Since the discovery of this remarkable Asterid thirty-five years ago by the Norwegian poet, Asbjørnsen, in the picturesque Hardanger Fjord, a considerable number of allied forms have rewarded the dredging operations in deep water which have since then been undertaken, and the type that was once thought so rare and limited in occurrence is now found to possess a world-wide distribution. Owing to the great similarity in general facies of all the members of the group, a certain laxity of conception as to the generic scope of *Brisinga* sprang up, and a number of species were provisionally set down as *Brisinga* which present characters that entitle them to stand as independent genera. In my preliminary note on the deep-water forms of the starfishes collected by the Challenger, I myself[1] referred to a number of these under the name of *Brisinga*. In 1885, Perrier[2] proposed a limitation of the genus, with which I entirely concur; indeed, prior to the publication of his memoir on the Asteroidea of the "Travailleur" and "Talisman" Expeditions, I had drawn up the synopses of species here given, in which the forms now placed under *Odinia* and *Freyella* were recognised as independent genera; for these I have great pleasure in adopting the admirably chosen names assigned to them by my learned colleague, in preference to the MS. names I had proposed to give them.

[1] Narr. Chall. Exp., 1885, vol. i., pp. 607–617. [2] *Ann. Sci. Nat.* (Zool.), 1885, t. xix. Art. No. 8.

The genus *Brisinga* as now defined is limited to those forms in which the abactinal skeleton of the rays is confined to isolated transverse ridges limited to the basal portion of the ray, and in which the abactinal membrane is entire, and not punctured by papulæ.

Synopsis of the Species included in the Genus Brisinga *herein described.*

A. Transverse calcareous ridges prominent and robust.
  a. Rays robust, nine to thirteen in number. Transverse ridges broad and robust (15–20 in number). Ambulacral tube-feet not separated by two spinelets . . . . . *coronata.*
  b. Rays delicate, eight in number. Transverse ridges thin and high (10–12 in number). Ambulacral tube-feet separated by two horizontally placed parallel spinelets . . . . . *verticillata.*

B. Transverse calcareous ridges moderately prominent or more or less rudimentary.
  a. Ridges complete. Tegumentary prickles in the abactinal membrane.
    a. Rays eleven in number. Ambulacral tube-feet not separated by two equal horizontally disposed spinelets.
      α. Adambulacral armature with three inner spinelets, all small. Actinal spines at base of ray needle-like. With crowded spinelets on the transverse ridges . . . . *endecacnemos.*
      β. Adambulacral armature with two inner spinelets, one large. Actinal spines at base of ray robust, clavate, with a coronate extremity. With widely spaced spinelets on the transverse ridges . . . . . *cricophora.*
    b. Rays seven in number. Ambulacral tube-feet separated by two equal horizontally disposed spinelets . . . . . *armillata.*
  b. Ridges incomplete and more or less rudimentary. No tegumentary prickles in the abactinal membrane.
    a. Adambulacral armature with one inner spinelet. Lateral spines short. Calcareous ridges feebly developed . . . . . *membranacea.*
    b. Adambulacral armature with three or four inner spinelets. Lateral spines long. Calcareous ridges rudimentary, never complete . *discincta.*

Chorology of the Genus Brisinga.

a. Geographical distribution :—

Atlantic: Six species between the parallels of 10° and 70° N.

Brisinga coronata, off the Lofoten Islands, the west coast of Norway, south of Rockall, west coast of Ireland, and west coast of Spain. Also in the Mediterranean, dredged by the "Travailleur" and "Talisman" (*fide* Perrier). *Brisinga endecacnemos*, off the west coast of Norway, between the Faeröe and the Shetland Islands, off the south-west coast of Ireland, in the Bay of Biscay, west of Ushant, and off the west coast of Spain. *Brisinga mediterranea*, between Marseilles and Corsica. **Brisinga cricophora*, north-

west of St. Thomas, Virgin Islands. *Brisinga costata*, off the east coast of the United States of North America, between Cape Hatteras and Nova Scotia. **Brisinga verticillata*, off the coast of North America, east of New Jersey.

Southern Ocean: Two species between the parallels of 40° and 50° S.
**Brisinga membranacea*, between Marion Island and the Crozet Islands, and west of the Crozet Islands. **Brisinga discincta*, south of Australia.

Pacific: One species between the parallels of 30° and 40° N.
**Brisinga armillata*, off the coast of Japan, south of Kawatsu.

β. *Bathymetrical range:* 100 to 2600 fathoms.
Greatest range of one species: *Brisinga mediterranea*, 301 to 1454 fathoms (*fide* Perrier).

γ. *Nature of the Sea-bottom:* *Brisinga armillata* and *Brisinga verticillata* on Blue mud; *Brisinga coronata* on Sandy clay; *Brisinga discincta* on Red clay; *Brisinga membranacea* on Globigerina and Diatom ooze; *Brisinga cricophora* on Pteropod ooze.

The species collected by the Challenger Expedition are indicated in the foregoing list by an asterisk.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Brisinga armillata . .	Pacific.	1875	Blue mud.
Brisinga coronata . .	Atlantic.	220 to 1366	Sandy clay.
Brisinga costata . . .	Atlantic.	888 to 2021	... ...
Brisinga cricophora . .	Atlantic.	390	Pteropod ooze.
Brisinga discincta . .	Southern.	2600	Red clay.
Brisinga endecacnemos . .	Atlantic.	100 to 1095	... ...
Brisinga mediterranea . .	Atlantic.	301 to 1454	... ...
Brisinga membranacea . .	Southern.	1375 to 1600	Globigerina and Diatom ooze.
Brisinga verticillata . .	Atlantic.	1350	Blue mud.

1. *Brisinga endecacnemos*, Asbjørnsen.

Brisinga endecacnemos, Asbjørnsen, 1856, Fauna Litt. Norvegiæ, Andet Hefte, p. 95, tab. ix. figs. 1–15.

Localities.—"Porcupine" Expedition:
*Off Valentia. Depth and conditions not stated.
*Station 45, 1869. South-west of Cape Clear. Lat. 51° 1′ 0″ N., long. 11° 21′ 0″ W. Depth 458 fathoms. Bottom temperature 8°·9 C.; surface temperature 15°·9 C.

Station 74, 1869. Between the Faeröe and Shetland Islands. Lat. 60° 39′ 0″ N., long. 3° 9′ 0″ W. Depth 203 fathoms. Bottom temperature 8°·7 C.; surface temperature 11°·4 C.

*Station 4, 1870. West of Ushant. Lat. 48° 32′ 0″ N., long. 9° 59′ 0″ W. Depth 717 fathoms. Bottom temperature 7°·5 C.; surface temperature 16°·3 C.

*Station 6, 1870. West of Ushant. Lat. 48° 26′ 0″ N., long. 9° 44′ 0″ W. Depth 358 fathoms. Bottom temperature 10°·0 C.; surface temperature 16°·9 C.

*Station 14, 1870. Off the west coast of Spain. Lat. 40° 6′ 0″ N., long. 9° 44′ 0″ W. Depth 469 fathoms. Bottom temperature 10°·8 C.; surface temperature 18°·4 C.

*Station 17, 1870. Off the west coast of Spain. Lat. 39° 42′ 0″ N., long. 9° 43′ 0″ W. Depth 1095 fathoms. Bottom temperature 4°·3 C.; surface temperature 19°·8 C.

Remarks.—The stations marked with an asterisk in the above list are recorded by Sir Wyville Thomson in The Depths of the Sea. All the examples of this species received by me, excepting fragments from Station 74, are placed together and bear no indication of the station or stations from which they were obtained.

2. *Brisinga coronata*, Sars.

Brisinga coronata, G. O. Sars, 1871, Vidensk-Selsk. Forhandlinger f. 1871, p. 5; On some remarkable forms of animal life from the great depths off the Norwegian coast, Part II., University Program, Christiania, 1875.

Localities.—"Porcupine" Expedition:

Station 23, 1869. South of Rockall Bank. Lat. 56° 7′ 0″ N., long. 14° 19′ 0″ W. Depth 630 fathoms. Bottom temperature 6°·4 C.; surface temperature 14°·0 C.

Station 45, 1869. South-west of Cape Clear. Lat. 51° 1′ 0″ N., long. 11° 21′ 0″ W. Depth 458 fathoms. Bottom temperature 8°·9 C.; surface temperature 15°·9 C.

Station 13, 1870. Off the west coast of Spain. Lat. 40° 16′ 0″ N., long. 9° 37′ 0″ W. Depth 220 fathoms. Bottom temperature 11°·0 C.; surface temperature 18°·1 C.

Remarks.—Other examples were also obtained during the "Porcupine" Expedition, but unfortunately bear no indication of the station at which they were taken.

3. *Brisinga verticillata*, n. sp. (Pl. CIX. figs. 9–11).

Rays eight. R = 175 mm.; r = 6·5 mm. R < 27 r. Breadth of a ray at the base, 4 mm.; at the widest part of the ovarial inflation, 5 mm. (measured at 30 mm. from the disk); midway between the disk and the extremity, 2·5 mm.

Rays very elongate and slender, subcylindrical and depressed at the base, uniform in breadth for a short distance, then slowly swelling into a short, slightly fusiform, ovarial inflation, which gradually contracts and terminates at about 40 mm. from the disk, the

inflated region only occupying about 23 mm. Beyond this the section of the ray is subtriangular with a truncate median carination.

The disk is very small and depressed, with the abactinal surface subplane and nearly on the same level as the base of the rays, the margin being slightly bevelled. The abactinal area of the disk is covered with a delicate membrane, beset with minute, papilliform, skin-covered spinelets, all of uniform height and distinctly spaced. The membrane which covers the abactinal surface of the rays is extremely delicate and quite transparent. The inner portion of the ray, about one-third of the length, is furnished with from ten to twelve transverse annular ridges, seven or eight of which are remarkably high and prominent in relation to the size of the ray. The ridges are rather widely spaced, their distance apart being equal to the length of two or three adambulacral plates, and they form a rigid narrow crest, composed of small imbricating ossicles, which bear small but robust conical spinelets, rather widely and equidistantly spaced. One or more narrow transverse band-like sacculi, crowded with minute pedicellariæ, occur on the abactinal membrane in the interspaces between the ridges, but no tegumentary spicules are present. Beyond the ovarial region the abactinal membrane is extremely delicate and is occupied only by the bands of pedicellariæ.

The ambulacral furrow is wide and occupies about 1·75 mm. at a part where the ray is 3 mm. (about 50 mm. from the disk). The adambulacral plates are longer than broad, measuring about 1·5 mm. at 50 mm. from the disk, and the furrow margin of the plate is conspicuously concave. The adambulacral armature consists of:—(1.) Two small inner spinelets directed horizontally over the furrow. (2.) A longer, more robust spine, standing perpendicularly on the actinal surface of the plate. The lateral spine is borne on a small rudimentary infero-marginal plate, so intimately united to the adambulacral plate as to appear an integral part of it. The spine, which is remarkably delicate and needle-like, measures 8 mm. at about 70 mm. from the disk, and is enveloped in an extremely thin membrane with numerous pedicellariæ. The actinal spine is shorter and even more delicate, and is so fragile that I have been unable to find one unbroken near the region indicated. Nearer the disk they measure 2·5 to 3 mm. in length, and are invested with a delicate membranous sheath bearing pedicellariæ. The two small inner or furrow-spines are equal, less than 1 mm. in length, and are invested with a delicate membrane expanded into a slight sacculus at the tip and bearing a few pedicellariæ; one is placed at each extremity of the plate, and it thus follows that there are two small spinelets standing parallel to one another between each consecutive ambulacral tube-foot.

The actinostome is large and measures 8 mm. in diameter in a disk 13 mm. in diameter. The mouth-plates are moderately large in comparison with the size of the disk, and the united pair have a prominent median keel along the line of juncture, which is imperfectly closed. Their armature consists of two small spines less than 1 mm. in length on the adoral margin of each plate, the inner one, when directed horizontally over the

buccal membrane, being parallel to the median interradial line, the outer one radiating outward at an angle of about 45° in the same plane. These spinelets are covered with delicate membrane, upon which a few microscopic pedicellariæ are borne near the tip. Midway on the actinal surface of the plate is a single, small, tapering, secondary or superficial spinelet, about 1·75 mm. in length, also invested with membrane bearing pedicellariæ. At the aboral end of each plate is a single small invested spinelet, directed horizontally over the ambulacral furrow, and separating the first and second tube-feet. It is similar in character and size to the small inner spinelet on the adambulacral plates above described.

The madreporiform body, which is small and subtubercular, is situated close to the margin of the disk, and it is marked with very few and simple striation furrows.

Colour in alcohol, a bleached ashy grey, with a slight brownish or flesh-coloured shade on the ovarial regions owing to the transparency of the membrane allowing the internal organs to be distinctly visible.

Locality.—Station 46. Off the coast of North America, east of New Jersey. May 6, 1873. Lat. 40° 17′ 0″ N., long. 66° 48′ 0″ W. Depth 1350 fathoms. Blue mud. Bottom temperature 37°·2 Fahr.; surface temperature 40°·0 Fahr.

Remarks.—This species, although allied to *Brisinga endecacnemos* and *Brisinga armillata* in many points of general detail, is readily distinguished from the former by the smaller number of rays, by their great delicacy, as well as by the delicacy of all their appendages, by the small and limited ovarial inflation, by the great prominence of the transverse ridges over these regions, by the absence of tegumentary spicules, and by the armature of the adambulacral plates and mouth-plates.

Brisinga verticillata may also be distinguished from *Brisinga armillata* by the number of rays, by their great delicacy, by the character of the ovarial regions, and by the great prominence of the transverse calcareous ridges. The general habit of the two species is quite different.

4. *Brisinga cricophora*, n. sp. (Pl. CIX. figs. 6–8).

Rays eleven. R = ?; r = 10 mm. Breadth of a ray at the base, 6·25 mm.; at the widest part of the ovarial inflation, 7 mm. (measured at 25 mm. from the disk); at 120 mm. from the disk, 5 mm.

Rays very long and narrow, cylindrical, and slightly depressed at the base, gradually swelling into a very elongate, slightly fusiform ovarial inflation, which contracts still more gradually and terminates imperceptibly, being altogether lost at 75 mm. from the disk. Beyond this the section of the ray is subtriangular, with a broad truncate median carination; the rays are rather broad and depressed, much more so than in *Brisinga endecacnemos*.

The disk is small and depressed, with the abactinal surface plane and at a higher level than the base of the rays, the margin standing nearly vertical and being abruptly rounded at the junction with the abactinal surface. The whole abactinal surface is covered with minute, papilliform, skin-covered spinelets, all of uniform height, closely placed but distinctly spaced. The membrane which covers the abactinal surface of the rays is very delicate and semitransparent. The inner portion of the ray, as far as the ovarial region extends, is furnished with transverse annular ridges, about twenty-three or twenty-four in number. The ridges, which are equidistantly spaced and are opposite to alternate adambulacral plates, are very flexuous, and not unfrequently two neighbouring ridges on one side of the ray may be joined by a longitudinal prolongation in the median radial line and united to a single ridge on the opposite side of the ray, apparently corresponding to their interspace. The ridges are very narrow and prominent, and are formed of minute imbricating ossicles, which bear very small, isolated, conical spinelets, the prominence of the ridges being greater and the spinelets much more widely spaced than in *Brisinga endecacnemos*. The abactinal membrane between the ridges bears narrow saccular bands crowded with minute pedicellariæ, from one to three being present in each interspace. These traverse the ray from side to side or may be interrupted and irregular, and frequently conform to the flexure of the calcareous ridges. Minute spiniferous spicules are also present on the membrane of the ovarial region, and are most numerous at the sides of the ray and over the entire base between the disk and the ovarial inflation. Beyond the ovarial region the abactinal membrane is extremely delicate, and the saccular bands, which are broad and regular, are equally spaced and traverse the ray.

The ambulacral furrow is wide and measures 3·5 mm. at a part where the ray is 7·5 mm. (about 75 mm. from the disk). The adambulacral plates are longer than broad, measuring about 2 mm. at 75 mm. from the disk, and the furrow margin of the plate is rather deeply concave. The adambulacral armature consists of:—(1.) Two small spines on the furrow margin, one attached near the adoral end of the plate, which measures about 2 mm., and the other near the aboral end, but being in the same line as the adoral spine is consequently not at the extremity of the plate. This spine measures 3·5 mm. Both these spines are cylindrical, tapering, and covered with a delicate membrane bearing numerous small pedicellariæ. (2.) On the actinal surface of the plate is an elongate, delicate, tapering spine measuring 8 to 9 mm., and invested with a membranous sheath, crowded with minute pedicellariæ, which develops a short saccular extension at the extremity.

The lateral spine at about 75 mm. from the disk is also about the same length, 8 to 9 mm., or a shade longer. It is very delicate, and is similarly invested with a membranous sheath crowded with minute pedicellariæ. It is articulated on the lowest plate of the transverse annular ridge—a rudimentary infero-marginal plate—which is so intimately united with the adambulacral plate as to appear like a tubercular eminence of that plate. Further out on the ray the lateral spines are a little longer, but I have not found any

exceeding 11 mm. in length. The innermost twelve or fourteen actinal spines on the adambulacral plates are modified in shape in a remarkable manner. They are robust, about 5 mm. in length, decreasing as they approach the disk, and have a large, flaring, truncate extremity, the component rods becoming enlarged and fusiform at a definite distance from the end, which produces the appearance of a superadded, composite, flower-like head to the shaft.

The actinostome is large and measures 12·5 mm. in diameter in a disk 20 mm. in diameter. The mouth-plates are small and insignificant, and slightly prominent at their aboral end. Their armature consists of one small spine on the adoral margin, invested with a thin membranous sheath extended into a vermiform sacculus, the whole about 2·5 mm. in length, and bearing numerous minute pedicellariæ. On the actinal surface of each plate are two spinelets with greatly prolonged sacculi, one behind the other, and forming two pairs on each mouth angle, the anterior pair measuring about 5·5 mm., and the posterior pair somewhat less. The sacculi are crowded with microscopic pedicellariæ.

The madreporiform body, which is prominent and subtubercular, is situated at the margin of the disk, and nearly on the curvature uniting the abactinal surface and the lateral wall.

Colour in alcohol, a bleached ashy white, with a slight flesh-coloured shade on the ovarial regions.

Locality.—Station 24. North-west of St. Thomas, Virgin Islands. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. Depth 390 fathoms. Pteropod ooze. Surface temperature 76°·0 Fahr.

Remarks.—This form is very nearly allied to *Brisinga endecacnemos;* in fact, owing to the fragmentary nature of the material at my disposal, I felt great hesitation at first in ranking it as a distinct species. A careful and comparative study of the specimens, however, has led me to believe that this step is fully warranted, and that *Brisinga cricophora* may be distinguished by the narrower and more prominent annular ridges with small widely spaced spinelets; by the presence and character of the sacculi crowded with pedicellariæ; by the more limited position of the tegumentary spicules; by the more elongate and less inflated ovarial regions; by the relatively broader and more depressed rays; by the relative proportions of the actinal and lateral spinelets; by the remarkable form of the actinal spinelets on the adambulacral plates at the base of the ray, and by the character of the armature of the adambulacral plates and mouth-plates.

5. *Brisinga armillata*, n. sp. (Pl. CX. figs. 1–3).

Rays seven. R = 240 mm.; $r = 9$ mm. $R > 26\ r$. Breadth of a ray at the base, 4·5 mm.; at the widest part of the ovarial inflation, 7·5 mm. (measured at 24 mm. from the disk); at 100 mm. from the disk, 4·5 mm.

Rays very long and attenuate, but of a comparatively robust habit in proportion to the small size of the disk, when compared with other species of the genus, narrow and cylindrical at the base, but gradually swelling into an elongate fusiform ovarial inflation, which contracts gradually and terminates at 45 to 48 mm. from the disk, thus occupying about the proximal fifth of the length. Beyond the ovarial inflation the ray is subtriangular, with a broad median carination, and tapers gradually to the extremity.

The disk is small and subdepressed, with the abactinal surface subplane and on the same level as the base of the rays or even slightly lower. The abactinal surface is covered with an exceedingly delicate semitransparent membrane, beset with very minute microscopic spinelets, each borne on a small subcircular spicule-like plate buried in the membrane and widely spaced. No definite order of arrangement is distinguishable amongst these spiniferous spicules, and the delicacy of the abactinal membrane is so great that traces of the internal organs may be seen through the interspaces. The membrane which covers the abactinal surface of the rays is even more delicate than that of the disk. The inner portion of the ray, as far as the ovarial region extends, is furnished with transverse annular ridges, similar to those in *Brisinga endecacnemos*. These are very narrow, often irregular, and more or less flexuous, and their normal position appears to be opposite alternate adambulacral plates, but this is not invariable. A few isolated spicules may be found in the intermediate spaces, and saccular bands crowded with small pedicellariæ are present, but from the condition in which the specimen now is, I am unable to remark on their character or dimensions, but where preserved they appear to be broad continuous bands extending from margin to margin. The transverse keels or ridges are formed of a number of small ossicles imbricating on one another and bearing minute, isolated, short, thorn-like spinelets. Beyond the ovarial region the abactinal membrane was of great delicacy, and where present may be seen to form transverse folds or plications, but owing to its delicacy it is wanting on the greater portion of the ray.

The ambulacral furrow is wide and measures 2·75 mm. at a part where the ray is 4·5 mm. (about 70 mm. from the disk). The adambulacral plates are longer than broad, measuring 2 mm. at 70 mm. from the disk, and the furrow-margin of the plate is deeply concave. The adambulacral armature consists of:—(1.) two small inner spinelets, directed horizontally over the furrow; (2.) a longer and more robust spine standing perpendicularly on the actinal surface of the plate; and (3.) a still longer lateral spine, usually borne on every third plate, *i.e.*, with two unarmed plates between, but sometimes there is only one. The two small inner spines are attached, one near the adoral and the other near the aboral end of the furrow-margin of the plate, and are directed horizontally over the furrow at a right angle to the margin. It thus follows that there are two small spinelets between each consecutive ambulacral tube-foot. These spines are of equal size, less than 1 mm. in length, cylindrical, and covered with extremely delicate membrane, on which are borne a few comparatively large pedicellariæ. The actinal spine is articulated on a

small tubercular eminence situated a little on the aboral side of the middle of the actinal surface of the plate. It is 3 to 4 mm. in length at 70 mm. from the disk, cylindrical, tapering, and invested with a delicate membranous sheath crowded with minute pedicellariæ. The lateral spines are articulated on a rudimentary infero-marginal plate ankylosed to the adambulacral plate, which looks like a prominent tubercular eminence near its aboral extremity. The spines are delicate, measuring 10 to 12 mm. in length at about 70 mm. from the disk, and are encased in a delicate membranous sheath crowded with very minute pedicellariæ, which develops a saccular distal prolongation. On the greater part of the ray, two unarmed adambulacral plates usually intervene between those which bear lateral spines, but on the outer part of the ray their occurrence on alternate plates is frequent.

The actinostome is large, measuring about 10·5 mm. in diameter in a disk 17·5 mm. The buccal membrane is semitransparent, and has a slightly rugose appearance. The mouth-plates are comparatively large and occupy the whole breadth of the actinostomial ring. The adoral margin of the united pair is almost straight, and the lateral margins converge slightly as they approach the mouth, forming a sharp angle with the adoral margin. The median suture line is widely open, and the opposed margins of the plates are slightly raised. Each plate bears on its adoral margin two small mouth-spines. The inner pair are situated near the outer extremity of the adoral margin and are consequently wide apart; they are directed horizontally over the buccal membrane and are parallel to one another and the median interradial line. The outer spinelets are attached close to the base of the companion inner spinelet, and are directed horizontally but at a right angle to the direction of the inner spinelet, forming a bar across the ambulacral furrow at the margin of the actinostome. These marginal mouth-spines are about 1 mm. in length, are covered with delicate membrane, and do not appear to bear pedicellariæ generally, though a few isolated ones may be seen on the shafts in some cases. On the middle of the actinal surface of the plate is a cylindro-conical secondary mouth-spine, thick at the base and tapering to a point, about 2·75 mm. in length, covered with delicate membrane crowded with very small pedicellariæ, and articulated on a small tubercle.

The madreporiform body is prominent and subtubercular, oval in outline and with the greater diameter in the median interradial line; the central portion of its surface bears a few short striation furrows, presenting a rather compact disposition in comparison with the structure seen in some species of *Brisinga*. The position of the madreporiform body is internal or adcentral in relation to the "odontophore," from which it is clearly distinct; the so-called odontophores are superficially visible in the lateral wall of the disk as elongate casque-shaped plates.

Colour in alcohol, a bleached ashy white, with a slight pinkish or flesh-coloured shade on the ovarial regions of the rays and over parts of the abactinal surface of the disk, owing to the transparency of the membrane allowing the internal organs to be distinctly visible.

Locality.—Station 237. Off the coast of Japan, south of Kawatsu. June 17, 1875. Lat. 34° 37′ 0″ N., long. 140° 32′ 0″ E. Depth 1875 fathoms. Blue mud. Bottom temperature 35°·3 Fahr.; surface temperature 73°·0 Fahr.

Remarks.—The specimen above described consists of the disk and two entire rays, with portions of two others. At first sight its characters vividly recall those of *Brisinga endecacnemos*, but the species is readily distinguished by the smaller number of rays, by the character of the adambulacral armature, by the extraordinary delicacy of the abactinal membrane, and by the simplicity of the covering of the disk; the lateral margin of the disk is also distinctly bevelled in contrast to the more precipitous wall in *Brisinga endecacnemos*.

6. *Brisinga membranacea*, n. sp. (Pl. CX. figs. 8 and 9).

Disk and number of rays unknown. R = 75 mm. Breadth of a ray at the base, 2·5 mm.; at the widest part of the ovarial inflation, 3 mm. (measured at 12 mm. from the base of the ray); and midway between the extremities, 1·75 mm.

Rays elongate, slender, and tapering to a fine extremity, but they appear to be comparatively short in proportion to their robustness as compared with the majority of the species of *Brisinga;* subcylindrical and depressed at the base, thence swelling slightly and gradually into a very feebly developed ovarial inflation and as gradually contracting, the widest part being comparatively far removed from the base of the ray, which causes the ovarial region to appear to occupy quite the inner third of the length. Outward beyond this point the ray is subtriangular.

The abactinal surface of the ray is covered with an extremely thin and delicate membrane. On the inner third or fourth of the ray, that is to say on the ovarial region, there are a few irregularly disposed transverse annular calcareous ridges, eight or nine in number. These are remarkably narrow, and formed of very delicate elongate ossicles, some of which bear short, delicate, hair-like microscopic spinelets. Between the calcareous ridges and along the ray beyond the ovarial region are saccular transverse bands or areas crowded with small pedicellariæ.

The ambulacral furrow is wide and measures 1·5 to 1·75 mm. at a part where the ray is 2·75 mm., about 10 mm. from the base of the ray. The adambulacral plates are longer than broad, measuring 1·75 mm. at 10 to 15 mm. from the base of the ray; they are considerably constricted midway between their extremities, and the furrow-margin is distinctly concave. The adambulacral armature consists of:—(1.) one small inner spinelet directed horizontally over the furrow; (2.) a small actinal spine, standing perpendicularly on the actinal surface of the plate; (3.) a moderately long lateral spine, normally corresponding to every alternate plate, articulated on a small independent marginal plate. The small inner spine is attached near the aboral end of the plate, and is situated quite within

the furrow, over which it is directed horizontally and not quite at a right angle to the axis of the plate, but directed very slightly aborally. Its length is about equal to half the width of the furrow, and it is covered with a membrane so delicate and close fitting as to appear naked. Not more than one or two pedicellariæ are present, and these are often wanting. The actinal spine is articulated on a small tubercular eminence near the middle of the actinal surface of the plate; it is about 1·5 to 2 mm. in length at 20 mm. from the base of the ray, delicate, cylindrical, rather robust at its base and tapering to a sharp point, and is invested with a delicate membranous sheath crowded with minute pedicellariæ. The lateral spines are delicate, cylindrical, tapering, 3·5 to 4·0 mm. in length at 25 mm. from the base of the ray, and encased in a membranous sheath crowded with pedicellariæ, and each is articulated on a small, triangular, rudimentary plate—the representative of an infero-marginal plate. These small rudimentary plates are sutured to the adambulacral plates by the base of the triangle, and the lateral spine is then articulated on the aboral facet, the normal direction of the spine being consequently outward at an angle of about 45° to the axis of the ray, and this conspicuous little plate recalls in the most vivid manner the attachment of the pinnule of a *Comatula*. At the extreme base of the ray there are two of the rudimentary marginal plates (which Sars[1] named dorso-marginal); the first, which articulates on the so-called odontophore, is as long as the adambulacral plate on which it is superposed, whilst the next is very much smaller. I consider that these are the representatives of infero-marginal plates and not supero-marginal, as supposed by Sars—a mistake which I would suggest has arisen from the adambulacral plate appearing at first sight to stand as an inferior marginal plate in relation to these small plates. From the fact that the plates in question are attached to the adambulacral plates and the odontophore, and likewise when further out on the ray bear the lateral spine, it would, in my opinion, seem far more natural to rank them as the rudiments or representatives of infero-marginal plates than of supero-marginals.

Colour in alcohol, a rather dark brownish grey, the ambulacral tube-feet being dark brown.

Locality.—Station 146. Between Marion Island and the Crozet Islands. December 29, 1873. Lat. 46° 46′ 0″ S., long. 45° 31′ 0″ E. Depth 1375 fathoms. Globigerina ooze. Bottom temperature 35°·6 Fahr.; surface temperature 43°·0 Fahr.

Station 147. West of the Crozet Islands. December 30, 1873. Lat. 46° 16′ 0″ S., long. 48° 27′ 0″ E. Depth 1600 fathoms. Diatom ooze. Bottom temperature 34°·2 Fahr.; surface temperature 41°·0 Fahr.

Remarks.—*Brisinga membranacea* is remarkable for the extremely delicate and rudimentary character of the abactinal skeleton which is represented only by transverse bars

[1] On some remarkable forms of animal life from the great depths off the Norwegian coast, Part II., University Program, Christiania, 1875, p. 9.

on the ovarial region, of the narrowest and most attenuated description. It is further characterised by the absence of tegumentary prickles in the abactinal membrane, by the single small inner spinelet in the armature of the adambulacral plates, and by the comparatively short lateral spines.

7. *Brisinga discincta*, n. sp. (Pl. CX. figs. 4–7).

Disk and number of rays unknown. R = 180 mm. Breadth of a ray at the base, 4 mm.; across the middle part of the ovarial region, 3·8 mm. (measured at 14 mm. from the base); and at 100 mm. from the base, 2·75 mm.

Rays elongate and tapering throughout from the base, no special ovarial inflation perceptible; subcylindrical and depressed at the base but still with a subtriangular tendency; at a short distance from the base the true subtriangular form is assumed, the vertical height in proportion to the breadth being somewhat greater than usual, with the converging slopes straighter and less incurved, and the median carination narrow but sharply truncate.

Two ray fragments, which measure 114 and 66 mm. respectively, I believe from their width and general appearance to have both belonged to one ray; even in this case the terminal portion is still wanting to form an estimate of the full length.

The abactinal surface of the ray is covered with an extremely thin and delicate membrane; at the base of the ray there are two or three transverse annular bands, none really complete, of small narrow spicular plates, and rudiments of one or two still more incomplete, consisting of only one or two small plates at the margin of the ray. These are the aborted representatives of the annular ridges in other forms, and no other spicules are present in the membrane beyond this point in the species under notice. Tolerably numerous small pedicellariæ are present upon the membrane along the ray, and were probably disposed in transverse bands, this being distinctly the arrangement on the proximal part of the ray.

The ambulacral furrow is wide and measures 1·25 mm. at a part where the ray is 3 mm., about 40 to 50 mm. from the base. The adambulacral plates are fully twice as long as broad, measuring 2 mm. at about 50 mm. from the base. Both the furrow-margin and the outer margin are considerably incurved, and the ossicle is slightly flattened actinally and has somewhat of a twisted appearance when viewed from above; the adoral end is convex, the aboral concave, and the plates overlap considerably. The adambulacral armature consists of:—(1.) normally four small inner spinelets directed horizontally over the furrow, though sometimes only three are present; (2.) a small actinal spine standing perpendicularly on the actinal side of the plate; (3.) a long delicate lateral spine, articulated on a small rudimentary infero-marginal plate, corresponding to every third adambulacral plate, *i.e.* two unarmed adambulacral plates intervene between each successive lateral spine. Of the small inner spines, two, which stand close together and often one rather

above the other, are attached at the extreme aboral end of the plate; two similar spinelets, also near together, stand near but not close to the adoral end of the plate, and are likewise directed over the furrow. These inner or furrow spinelets are very delicate and hair-like, less than 1 mm. in length, and have attached to them one comparatively large pedicellaria, and occasionally apparently one or more at the base. Sometimes there is only one small spinelet at the aboral end of the plate. The actinal spine, which is short (about 1 mm. in length), but robust at the base and sharply tapering, is articulated on a small tubercle near the middle of the actinal surface of the plate, and is encased in a delicate membranous sheath with numerous pedicellariæ. The lateral spines are 17 to 18 mm. in length at 100 mm. from the base, very delicate, slender, and tapering, and are covered with an exceedingly thin membrane crowded with minute pedicellariæ and presenting a considerable saccular prolongation at the extremity. Each lateral spine is articulated on a small subtriangular plate—the rudimentary representative of an infero-marginal plate—attached by suture to the lateral margin of the adambulacral plate, and with its adoral side rounded, the last-named feature causing the plate at first sight to appear as a truncate tubercular eminence on the adambulacral plate. At the extreme base of the ray there are two of the rudimentary infero-marginal plates: the first, which articulates on the odontophore, is as long as the underlying adambulacral plate, but diminishes rapidly in height between its adoral and aboral ends; the second marginal plate is shorter than the first and tapers to a point. Beyond this are several elongate scale-like plates, which may perhaps be an aborted continuation of the marginal plates.

Locality.—Station 160. South of Australia. March 13, 1874. Lat. 42° 42′ 0″ S., long. 134° 10′ 0″ E. Depth 2600 fathoms. Red clay. Bottom temperature 33°·9 Fahr.; surface temperature 55°·0 Fahr.

Remarks.—*Brisinga discincta* is characterised by the almost complete abortion of the abactinal skeleton, this being represented only by a few minute plates on the ovarial region, which do not form a single entire transverse band. So far as I can judge from the fragments collected the alliance of this species to the form described by Perrier under the name of *Hymenodiscus* appears to be very close, and lends support to the doubt which I have expressed as to the generic independence of that form. *Brisinga discincta* may be further distinguished from the other members of the genus by the absence of tegumentary prickles in the abactinal membrane, by the presence of three or four inner spinelets in the armature of the adambulacral plates, and by the length of the lateral spines.

Genus *Freyella*, Perrier.

Freyella, Perrier, Ann. Sci. Nat. (Zool.), 1885, t. xix. Art. No. 8, p. 5.

The genus *Freyella*, like the genus *Odinia*, is due to the critical insight of M. Perrier. Species of both genera have previously been ranked as *Brisinga*, notwithstanding the

possession of characters which fully warrant their separation. As now classified, the species present a remarkable similarity of general facies, and the comparatively small amount of morphological plasticity exhibited by the genus is extraordinary, considering the wide geographical area over which it is distributed. The bathymetrical range is also remarkable, extending from the commencement of the continental zone to the greatest depth at which starfishes have been found.

The genus *Freyella* is distinguished from the other members of the Brisingidæ by having the disk and the basal portion of the rays covered with scale-like, calcareous plates, frequently imbricating, and forming a more or less compact calcareous casement. The plates bear one or more spinelets. No papulæ are present.

Synopsis of the Species included in the Genus Freyella, *herein described.*

A. Rays ten or more in number.
  a. Mouth-spines free and spiniform. Abactinal plating well-developed and imbricating.
    a. Mouth-spines proper three or four on each plate.
      α. Adambulacral armature with the inner spine doubled. Rays ten in number, broad and robust . . . . *pennata.*
      β. Adambulacral armature with the inner spine single. Rays seventeen in number, very delicate . . . *polycnema.*
    b. Mouth-spines proper one or two on each plate. Adambulacral armature with one inner spine. Rays usually more than ten in number (10 to 12).
      α. Abactinal plates bearing large spinelets with membranous sheaths crowded with pedicellariæ. Rays eleven or twelve in number . . . . . *echinata.*
      β. Abactinal plates bearing small spinelets with simple membrane devoid of pedicellariæ.
        i. Buccal membrane with largely developed papilliform villous appendages. Rays ten or eleven in number . . . . *fragilissima.*
        ii. Buccal membrane with no specially developed villous appendages.
          1. Rays constantly twelve in number. Spinelets on the abactinal plates few, one to three on each. Lateral spines rather short and not very delicate. Outer mouth-spines forming a bar across the ambulacral furrow . . . . . *bracteata.*
          2. Rays ten to twelve in number. Spinelets on the abactinal plates more numerous, five to ten on each. Lateral spines long and very delicate. Outer mouth-spines not forming a bar across the ambulacral furrow . . . . *dimorpha.*

b. Mouth-spines proper more or less aborted; when present confined in an attached membranous sac. Abactinal plating rudimentary, microscopic, and not imbricating. Rays ten. Lateral spines very long. Ovarial regions very short . . . . . *remex.*

B. Rays less than ten in number.

a. Rays six in number. Mouth-spines straight and spiniform.

a. Abactinal plating extending beyond the ovarial region; each plate with a central tubercle only, bearing a spinelet covered with membrane crowded with pedicellariæ. One mouth-spine proper . . . . . *tuberculata.*

b. Abactinal plating not extending beyond the ovarial region; each plate bearing two or three small spinelets, covered with simple membrane devoid of pedicellariæ. One or two mouth-spines proper . . . . . *benthophila.*

b. Rays nine in number. Mouth-spines subcrescent or scimitar-shaped. Adambulacral armature with one inner spine. Abactinal plates with three to five small spinelets . . . . . *heroina.*

c. Disk and number of rays unknown. Probably nearly allied to the preceding species, but the segments of the ray are longer. Adambulacral armature devoid of an inner spine, except at the base of the ray. Abactinal plates with one to three small spinelets . *attenuata.*

Chorology of the Genus Freyella.

a. Geographical distribution:—

Atlantic: Seven species between the parallels of 50° N. and 10° S.

Freyella americana, off Nova Scotia. **Freyella bracteata*, off the coast of North America, east of New Jersey and Massachusetts, and south of Nova Scotia. *Freyella elegans*, between Cape Hatteras and Nova Scotia. *Freyella spinosa*, off the coast of the Soudan. **Freyella tuberculata*, between the Canary Islands and Cape Verde Islands, and between the south coast of Africa and the Island of Ascension. *Freyella sexradiata*, dredged by the "Talisman" (? loc.). *Freyella edwardsi*, dredged by the "Travailleur" (? Mediterranean).

Southern Ocean: One species between the parallels of 45° and 65° S.

**Freyella fragilissima*, between Marion Island and the Crozet Islands, and in the neighbourhood of the pack ice near the Antarctic circle.

Eastern Archipelago: One species between the parallels of 0° and 20° N.

**Freyella echinata*, in the Celebes Sea between Celebes and Mindanao, and west of the island of Luzon, and extending into the Pacific.

Pacific: Eight species between the parallels of 40° N. and 45° S.

**Freyella heroina*, in the Mid-North Pacific, near the meridian of 170° E. **Freyella pennata*, off the coast of Japan, south of Kawatsu. **Freyella attenuata*, west of the Mariana or Ladrone Islands. **Frey-*

ella echinata, midway between the Pelew Islands and New Guinea, and extending into the Eastern Archipelago. **Freyella dimorpha*, off Torres Strait, Pacific side. **Freyella remex*, in the Coral Sea, south-east of New Guinea. **Freyella polycnema*, north-east of the Kermadec Islands. **Freyella benthophila*, in the Mid-South Pacific, near the meridian of 130° W.

β. *Bathymetrical range:* 175 to 2900 fathoms.

Greatest range of one species: *Freyella elegans*, 606 to 2021 fathoms (*fide* Verrill).

With the exception of *Freyella americana*, which occurs in the Continental zone, all the other species are confined to the Abyssal zone. The following eight species live in depths greater than 2000 fathoms: *Freyella attenuata*, *Freyella benthophila*, *Freyella echinata*, *Freyella elegans* (*fide* Verrill), *Freyella heroina*, *Freyella remex*, *Freyella sexradiata* (*fide* Perrier), and *Freyella tuberculata*.

γ. *Nature of the Sea-bottom: Freyella benthophila*, *Freyella heroina*, and *Freyella remex*, occur on Red clay; *Freyella bracteata*, *Freyella echinata*, and *Freyella pennata*, on Blue mud; *Freyella echinata* is also found on Globigerina ooze; *Freyella dimorpha*, *Freyella fragilissima*, and *Freyella tuberculata* on Globigerina ooze, *Freyella fragilissima* is also found on Diatom ooze; *Freyella attenuata* on Radiolarian ooze. *Freyella polycnema* inhabits hard ground.

The species collected by the Challenger Expedition are indicated in the foregoing list by an asterisk.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Freyella americana	Atlantic.	175	... ...
Freyella attenuata	Pacific.	2300	Radiolarian ooze.
Freyella benthophila	Pacific.	2550	Red clay.
Freyella bracteata	Atlantic.	1250 to 1350	Blue mud.
Freyella dimorpha	Pacific.	1400	Globigerina ooze.
Freyella echinata	Eastern Archipelago and Pacific.	1050 to 2150	Blue mud; Globigerina ooze.
Freyella edwardsi	Atlantic.	...	... ...
Freyella elegans	Atlantic.	606 to 2021	... ...
Freyella fragilissima	Southern.	1375 to 1975	Globigerina ooze; Diatom ooze.
Freyella heroina	Pacific.	2900	Red clay.
Freyella pennata	Pacific.	1875	Blue mud.
Freyella polycnema	Pacific.	600	Hard ground.
Freyella remex	Pacific.	2440	Red clay.
Freyella sexradiata	Atlantic.	2733	... ...
Freyella spinosa	Atlantic.	784	... ...
Freyella tuberculata	Atlantic.	2350 to 2400	Globigerina ooze.

1. *Freyella pennata*, n. sp. (Pl. CXI. figs. 1–4).

Rays ten. R = 200 to 240 mm.; $r = 11$ mm. R > 20 r. Breadth of a ray at the base, 6 mm.; at the widest part of the ovarial expansion 10 to 11 mm., this latter dimension being situated at about 15 mm. from the place of junction with the disk; midway between the base and the extremity the breadth of the ray is 4·5 mm.

Rays of great length, delicate, subcarinately cylindrical (or, perhaps, more correctly, subtriangular and truncate along the median line), slightly constricted at the base and narrow for a short distance scarcely equal to twice the breadth and then expanding rather abruptly into a fusiform ovarial inflation, which gradually contracts and the ray from thence tapers regularly to the extremity.

The disk is small, elevated rather abruptly above the level of the rays at their base, with the abactinal surface subplane and undulating. The small narrow portion of the ray which intervenes between the disk and the ovarial swelling is cylindrical, and a longitudinal section through the median radial line would exhibit a rather deep concavity between the disk and the swelling, the descent being more rapid near the former than the latter. The lateral wall of the disk in the interbrachial arcs is vertical. The disk and the basal portion of the rays for some distance beyond the ovarial swelling are covered with a fleshy membrane through which protrude a number of very minute, delicate, uniform, pointed spinelets, so small that the spiniferous membrane as a whole only presents an appearance to the naked eye suggestive of a rather coarse velvet pile. When examined microscopically the membrane is found to be underlaid by a pavement of thin, delicate, irregularly suboval, imbricating calcareous plates, each of which bears from two to four small, cylindrical, tapering, pointed spinelets 0·6 to 0·8 mm. in length and a few small crossed pedicellariæ (about six or eight). The spinelets, which are of very simple structure and built up of not more than three or four outer rods, with scalariform dissepiments, are enclosed in a membranous sheath, the thickness of the invested spine being about 0·133 mm., and the thickness of the calcareous spine alone about 0·066 mm. near the base. The pedicellariæ, which are sessile and of the characteristic form found on Brisingidæ generally, are very small, a closed pedicellaria not measuring more than 0·135 mm., from the base to the apex of the valves. The pavement plates are of extreme delicacy, presenting a single layer of extremely fine calcareous network, the meshes having a diameter of about 0·022 mm., and rarely a few are slightly larger. This spiniferous, plate-paved membrane extends uninterruptedly and uniformly over the disk and along the basal portion of the rays for a distance of about 50 mm. from their attachment to the disk, in fact as far as the generative organs reach. From this point an exceedingly delicate membrane without plates covers the ray up to the extremity. This membrane is so fine and transparent that the ambulacral ossicles of the ray are clearly visible through it, indeed its presence is not at first sight detected, and the rays have the superficial appearance of being denuded of membrane beyond the point where the spiniferous membrane of the ovarial regions

terminates. The membrane is furnished with elongate saccular bands placed saddle-like upon the truncately arched abactinal surface of the ray with great regularity, one on each side of each pair of ossicles, limited, however, to the sides, and not united across the median line. The sacculi extend from the horizontal line of the ambulacral "vertebræ" to the margin of the ray, this dimension being about 2·5 mm., and the breadth of the band is about 0·75 to 1 mm. They have their surface crowded with very minute pedicellariæ, visible only under high magnification. These are similar to those already mentioned, but are smaller, their length being about 0·11 mm.

The section of the ray midway between the centre and the extremity gives an outline which may be described as subtriangular with the apex truncate, the greater portion of the base-line is occupied by the ambulacral furrow, the extremities of the line being represented by the adambulacral plates.

The angular margin of the ray is fringed by a continuous series of elongate lateral spines; these are attached to a rudimentary marginal plate ankylosed to the outer side of the adambulacral plates, and are directed horizontally and outward at an angle of less than 45° to the axis of the ray. They are usually borne on every other adambulacral plate, but occasionally they are present on two consecutive plates. Their presence is very irregular on the basal part of the ray (for about 25 mm.), and they are quite short and stunted (3·5 mm. in length) until the ovarial region is passed; they then increase in length, and continue to increase gradually to a slight degree, their greatest length being near the middle of the ray, where they measure about 12 mm., and then after some distance gradually diminish in length towards the extremity. The spines are delicate and cylindrical, about 0·26 to 0·3 mm. in thickness near the base, and taper throughout to an extremely fine, sharp point. The base forms a small condyle-like head, by which the spine is articulated to its plate. The spine is encased in a delicate membranous sheath, the surface of which is crowded with minute pedicellariæ, so small as to be quite invisible to the naked eye, and only giving the appearance of a delicate superficial asperity on the spinelet when examined with a hand-magnifier. The sheath is prolonged for a short distance beyond the extremity of the spine in the form of a slightly bulbous sac, which is usually turned a little to one side as if the spinelet maintained an attachment to one of the lateral walls of the sacculus rather than occupying a central position; furthermore, the membranous sheath does not taper in conformity with the tapering of the contained spine (see fig. 4). The pedicellariæ are of the same kind as those already noticed; they diminish a little in size as they approach the extremity of the spine, and the largest, which are situated near the base, measure about 0·1 to 0·116 of a millimetre in length.

The ambulacral furrow occupies nearly the whole of the actinal surface of the ray, being 2·5 mm. in width at a place where the whole ray is 5·75 mm. The adambulacral plates form the rest of the area, and have the appearance of constituting only a thin margin to the furrow; their shape as viewed from beneath is semicylindrical, with the furrow-

margin of the plate gently concave and forming a little bay along which the ambulacral tube-foot passes. Adjacent plates are united by a rather broad tract of muscular ligament, and when this is removed by alkali the plates appear to stand widely spaced. The armature of the adambulacral plates is very simple. On the middle of the plate one large spine stands perpendicularly; this is more than half the length of the lateral spines above described, its measurement being 6·5 mm., and like these it is clothed in a precisely similar membranous sheath, crowded with pedicellariæ, and furnished with a similar saccular expansion at the tip. On the inner portion of the ray this spine is truncate at its distal extremity and often flaring; beyond the ovarial region it is tapering and sharply pointed, and the spines increase slightly in length till the maximum is attained within the middle third of the ray. At the aboral extremity of the plate, and immediately on the furrow margin, is a very minute spinelet not more than a millimetre in length, and directed at an angle of about 45° over the furrow. This spine is cylindrical, tapering, and covered with a closely-fitting membrane, without the crowded pedicellariæ; two to six pedicellariæ, however, usually stand in a little group, and form a sort of collarette midway between the extremities of the spine. Occasionally this small inner spine is accompanied by a companion spine of similar size and character, standing close to it, but rather more adoral and higher in the furrow. On the outer margin of the plate, and articulating on a small rudimentary infero-marginal plate ankylosed to the adambulacral plate, and appearing like a subtubercular elevation near the aboral end, is the long lateral spine above described, and this as already noticed is usually present only on alternate plates. No other spines are borne on the adambulacral plates.

The actinostome is large and of wide expanse, occupying three-fifths of the actinal surface of the disk, its diameter being 12 mm., in a disk of 20 mm. diameter. Within its periphery, and at a higher level within the disk, extends a more or less broad tract of buccal membrane, in the centre of which is the large mouth. The muscular system of the buccal membrane is strongly developed, and the margin of the mouth is crenulated by the numerous plications, the lines of which upon the membrane near the mouth-opening have a verrucose appearance.

The mouth-plates are small and inconspicuous, the united pair forming a shield-shaped "mouth-angle," with a well-rounded margin adorally and subparallel sides. The median juncture is invisible on account of the investing membrane. On the adoral margin three or four mouth-spines stand on each side of the median line, equidistantly spaced, radiating apart, and directed over the buccal membrane; they are very little more than 1 mm. long (scarcely 1·5 mm.), the inner pair being perhaps a trifle longer than the others; the third spine (or the fourth when present) is placed a little further back from the margin, on the surface of the plate, than its predecessors, and is succeeded by a large secondary spinelet, 3·75 to 4 mm. long, quite on the surface of the plate but still near the margin; this is followed by one, or sometimes a pair of small spinelets, in the same

position as the spinelets arming the adambulacral plates, indeed from the fact that this spine (or pair of spines) separates the first and second pair of ambulacral tube-feet, it is doubtful whether they can properly be ranked with the mouth-plate armature or not. It is here easy to see that the secondary or superficial mouth-spine is the representative of the large outer perpendicular spine of the adambulacral armature throughout the ray; like them also it is encased in a membranous sheath crowded with pedicellariæ. The short marginal mouth-spines are cylindrical and tapering, covered with a close-fitting membrane, with a few isolated pedicellariæ on their shaft, usually situated more or less midway between the extremities.

The ambulacral tube-feet are stout and short, with a well-developed sucker-disk strongly invaginated centrally.

The madreporiform body is small and more or less hidden by the dermal spinelets of the disk; its presence, however, is indicated by the irregularity of spinelets about it, and its position is very little removed from the margin of the abactinal surface.

Colour in alcohol, a bleached yellowish white, the lateral spinelets being a purer white.

Locality.—Station 237. Off the coast of Japan, south of Kawatsu. June 17, 1875. Lat. 34° 37′ 0″ N., long. 140° 32′ 0″ E. Depth 1875 fathoms. Blue mud. Bottom temperature 35°·3 Fahr.; surface temperature 73°·0 Fahr.

Remarks.—*Freyella pennata* may be distinguished from the other members of the genus by the character of the armature of the mouth-plates and of the adambulacral plates, and by the presence of ten comparatively broad robust rays. The presence of the additional small spinelet on the furrow margin of the adambulacral plates appears to be dependent on age. In some large fragments of this species even three are present at the base of the ray, and form a small oblique series; this number, however, appears to be of rare occurrence.

2. *Freyella polycnema*, n. sp. (Pl. CIX. figs. 12–17).

Rays seventeen. R = ? mm.; $r = 5{\cdot}75$ mm. Breadth of a ray at the base, 1·8 mm.

Rays very delicate, subtriangular in section, with a median carination. Unfortunately only a few small fragments were collected, and all are detached from the disk and much mutilated; it is, therefore, impossible to state the length or to describe the general habit of the rays.

The disk is very small and depressed, with the abactinal surface slightly concave in its present state, and the margin abruptly bevelled to the base of the rays. The abactinal surface of the disk is covered with delicate membrane, which appears to be beset with minute plates bearing minute, conical, sharply pointed thornlets, distinctly spaced and quite microscopic in size. The membrane which covers the abactinal surface of the rays

is extremely delicate, and I do not detect in the fragments preserved any trace of an ovarial inflation. All the fragments appear to give a part, if not the whole, of the basal portion. This membrane is smooth and stretched, and a few widely spaced microscopic thornlets are present, grouped in more or less definite, rather broad, transverse bands. Examination under the microscope with suitable illumination reveals the presence of underlying plates upon which the thornlets are borne, and I have on these grounds ranked the form as a *Freyella*. A few small pedicellariæ are also present. There is no trace of any calcareous ridges or transverse sacculi with crowded pedicellariæ as in *Brisinga*. Beyond the basal part of the ray the abactinal membrane is extremely delicate and perfectly transparent.

The ambulacral furrow is wide, and measures about 1 mm. at a part where the ray measures 1·75 mm., at 11 mm. from what I believe to be the base of the ray. The adambulacral plates are much longer than broad, and the ninth measures nearly 1·5 mm. at 12 mm. from the base. The shape of the plate seen actinally greatly resembles that of a long caudal vertebra, its furrow margin being deeply concave, and the outer margin to a less degree. The breadth of the plate at the adoral extremity is rather greater than at the aboral extremity. The adambulacral armature consists of:—(1.) A minute, delicate, inner spine, directed over the furrow, about 0·5 mm. in length, placed at the aboral extremity of the plate, directed horizontally and at a slight angle adorally. This spinelet is covered with very thin membrane, on which are borne near the tip two or three or more small pedicellariæ. On the inner part of the ray a second spinelet is placed at the adoral end of the plate, but not more than half the size of that above described; it is also directed horizontally, but at a slight angle aborally. This small adoral spinelet does not appear to extend further than the eighth plate. (2.) On the actinal surface of the plate is an exceedingly delicate, tapering, needle-like actinal spine, the ninth from the base measuring 2·5 mm. in length. It is covered with a delicate membranous sheath, on which are borne a considerable number of pedicellariæ, and is articulated on a small tubercular eminence rather nearer the aboral end than midway on the plate. (3.) A single elongate, extremely delicate lateral spine is articulated on a small plate—a rudimentary infero-marginal plate—so intimately united to the adambulacral plate as to appear like a tubercular eminence on its surface. One appears to be present on each alternate plate. The twenty-second or twenty-third spine (which appears to be the longest on the fragments preserved) is about 5 mm. in length, and is invested with a thin membranous sheath, having a small saccular extension at the distal extremity, and bearing a great number of minute pedicellariæ usually on peduncles. The ambulacral ossicles or segments are remarkable for their length, and when seen from above have the appearance of two thin cylindrical rods placed side by side.

The actinostome is wide, and measures 7·5 mm. in diameter in a disk 11·5 mm. in diameter. The mouth-plates are small and rather elongate, slightly expanded and rounded anteriorly, and the median suture-line is not closed. Their armature consists of three

small spines on the adoral margin of each plate, which are directed horizontally over the buccal membrane, and radiate slightly apart, forming an elegant comb of six spinelets at each mouth-angle. The spinelets are subequal in length, invested with delicate membranous sheaths, on which are borne several comparatively large pedicellariæ. On the actinal surface of the plate is a single, comparatively large, and robust secondary or superficial spine, about 2 mm. in length, often, and perhaps normally, slightly flaring at the tip. This spinelet was invested with membrane, but I am unable to remark upon the character or number of the pedicellariæ borne upon it.

The madreporiform body, which is small and rather inconspicuous, is somewhat more remote from the margin than usual in the Brisingidæ. It is very simply punctured, a single figure-3-shaped striation and one or two isolated irregular pores being all that I can detect.

Colour in alcohol, a light dirty ashy grey.

Locality.—Station 171. North-east of the Kermadec Islands. July 15, 1874. Lat. 28° 33′ 0″ S., long. 177° 50′ 0″ W. Depth 600 fathoms. Hard ground. Bottom temperature 39°·5 Fahr. ; surface temperature 66°·5 Fahr.

Remarks.—*Freyella polycnema* differs from all the other species of the genus by the great number of its rays, by their delicacy, and by its small size. With the single exception of *Freyella pennata*, a large robust form with ten rays, it is the only other species with three true mouth-spines on each mouth-plate. By the above-mentioned characters, as well as by other minor points of detail, it may be readily distinguished from all the known species.

3. *Freyella echinata*, n. sp. (Pl. CXII. figs. 1–5).

Rays eleven. R = 202 to 212 mm. ; r = 12 mm. R > 17 r. Breadth of a ray at the base, 6 mm. ; at the widest part of the ovarial inflation, 9 mm., which is measured at a distance of about 18 mm. from the junction with the disk. At 40 mm. beyond the disk the width of the ray is 4·5 mm., and about midway between the base and the extremity, 3·2 mm.

Rays of great length and delicacy, cylindrical and narrow at the base, thence gradually swelling into a robust, but not greatly tumid, fusiform ovarial inflation, occupying less than the proximal fifth of the length (actually 37 mm.), beyond which the ray is subtriangular, with a truncate carination, and tapers gradually to a very attenuate extremity.

The disk is small and slightly elevated above the level of the rays at their base, with the abactinal surface probably capable of slight inflation ; in its present condition rather concave, which is somewhat emphasised by the moderate prominence of the basal arches of the rays, formed by the ambulacral plates at their junction with the disk. The ovarial inflation is not so great abactinally as laterally, hence the concavity seen in the profile view of the ray, intervening between the elevated margin of the disk and the ovarial inflation, is not so deep as in some species.

The fleshy membrane covering the disk and the basal portion of the rays, as far as the ovarial region extends, is underlaid by a pavement of rather large calcareous plates, of irregular suboval, subhexagonal, or subrhomboid form, with their greatest diameter transverse to the direction of the ray, which imbricate upon one another. On the disk the membrane is sufficiently thick to hide the plates from superficial observation; on the ovarial region, however, the membrane is thinner, and the plates can readily be seen with a hand-magnifier. On the disk the plates bear only very small spinelets, less than half a millimetre in length, and covered with membrane which develops a little clavate knob at the distal end. From their uniform size and equidistant spacing, the disk and the extreme base of the rays have a papillose appearance when seen with a hand-magnifier, or to the naked eye, as if covered with rather widely spaced granules. On the ovarial region, the majority of the plates bear a comparatively large spinelet, about 3 mm. (or 2–3) in length, articulated on a central tubercular eminence. The spine is delicate and tapering, but is encased in a membranous sheath, crowded with pedicellariæ, which gives it a rather robust appearance. A few isolated pedicellariæ are distributed over the surface of the plates, and occasionally one or two minute spinelets similar to those on the disk, covered with simple membrane. The pavement plates are usually composed of two or three layers of calcareous network, the meshes of which are somewhat larger in the centre of the plate, where they measure from 0·044 to 0·055 mm. in diameter. The isolated pedicellariæ, which are sessile and of the characteristic *Brisinga*-form, are comparatively large, varying from 0·185 to 0·210 mm. in length. The pedicellariæ on the plates of the ovarial region are of similar form, but rather smaller, and measure, near the base of the spines, from 0·140 to 0·155 mm., and diminish a little in size towards the distal end of the spine, where they measure about 0·120 mm. Outward beyond the ovarial regions the abactinal surface of the ray is covered with an exceedingly fine transparent membrane, and rather broad saddle-like sacculi, covered with pedicellariæ, are situated on the sides of the median keel, usually a pair between each pair of ambulacral ossicles. The "saddles" are nearly as broad as long, and those of a pair on the opposite sides of the ray are often connected by a little irregular band of pedicellariæ which crosses the median keel. The pedicellariæ are rather small and measure about 0·133 mm. At wide intervals apart a small spicule-like plate, suggestive of those found in Holothurians, is met with occasionally in this membrane.

The ambulacral furrow occupies nearly the whole of the actinal surface of the ray, as usual in the Brisingidæ, its width in this species being about 2·5 mm. at a place where the ray is 4 mm. broad. The adambulacral plates consequently form a very narrow margin, which is rounded semicylindrically. The plates are rather short, and united by a broad tract of ligament, and their inner surface presents a semicircular concavity towards the furrow. Their armature consists of one small spinelet at the aboral extremity of the plate, its length rather less than half the width of the furrow, over which it is directed nearly horizontally

and at a right angle to the direction of the ray. The spine is delicate and tapering, covered with membrane, and a few pedicellariæ are usually congregated near the distal extremity. On the middle of the plate one large spine stands perpendicularly; it measures 5 to 6 mm. in length, and is encased in a membranous sheath crowded with pedicellariæ. The pedicellariæ are similar to those previously noticed, and measure from 0·175 to 0·2 mm. in length on a spine near the base of the ray. On the inner portion of the ray, extending perhaps half way along the ovarial swelling, these spines are flaring and flattened at the tip, with a truncate extremity coarsely crenulate, and the membranous sheath is not continued over this expanded portion, but terminates abruptly in a roll at its commencement. The flattened extremity is transverse to the direction of the ray. Beyond the ovarial region the spine is delicate, tapering, and sharply pointed, and the membrane has a saccular prolongation. The long lateral spines which fringe the margin of the rays do not occur on every plate, but usually on alternate ones; sometimes, however, two unarmed plates are together, and rarely two succeeding plates bear a lateral spine. The spines, which are of great length and delicacy, measure from 14 to 19 mm. near the middle of the ray, are articulated on a rudimentary infero-marginal plate ankylosed to the outer margin of the adambulacral plate, and are enveloped in a delicate membranous sheath crowded with pedicellariæ, which develops a saccular prolongation at the distal extremity. Very few lateral spines are present on the ovarial region, and only on the outer part. The spines here are short (about 4 mm.), and with their membrane appear more robust; they increase in length as they proceed outward, and again diminish at the extremity of the ray. The pedicellariæ are attached to the membrane by long thread-like stalks, and the valves when closed measure 0·11 mm. on a spine 12 mm. long, from near the middle of the ray. The thickness of the spinelet, just above its widely expanded articulatory base, is only 0·177 mm.

The actinostome is large and of wide expanse, as in all the group; its diameter is 14·5 mm. in a disk of 20 mm. diameter. Within its periphery, and at a higher level, is a broad tract of delicate buccal membrane surrounding the widely open mouth. The membrane is semitransparent, and the internal organs are more or less clearly visible through it; the margin is strongly muscular, and has a subvillous or papillose appearance.

The mouth-plates are small and quite inconspicuous, and the median suture line is indiscernible. The adoral margin of the united pair in each "mouth-angle" is semicircular, and four small mouth-spines are borne upon it, two on each plate. The inner spine on each plate stands close to the median line of juncture, forming a pair nearly parallel to one another and directed horizontally towards the centre of the mouth. The other mouth-spine on each plate is also directed horizontally, but at an angle of about 45° to the direction of the inner spine. The marginal mouth-spines are short (2 mm. in length), and are covered with a thin membranous sac, slightly expanded midway between the extremities, which gives a subfusiform appearance to the spinelet, and a few isolated pedicellariæ are

borne upon it, usually in the region of the swelling, or extending towards the base, the distal extremity being left free. A robust-looking secondary spine, 4 mm. in length, is placed well back on the surface of each plate. These spines stand perpendicularly, and are encased in a membranous sheath with crowded pedicellariæ, precisely similar to the large perpendicular spine in the adambulacral armature throughout the ray.

The ambulacral tube-feet are short and stout, tapering a little towards the distal extremity, which terminates with a well-defined and centrally deeply invaginated terminal disk.

The madreporiform body, though small, is remarkably conspicuous on account of being prominent and almost semiglobular. Its outline is circular, 2·5 mm. in diameter, and it is situated at about the same distance from the margin of the disk. There are only about half-a-dozen deep, widely spaced striations upon its surface; some, which are simply wavy, traverse the area, whilst others are convolute, their disposition being altogether irregular and without any approach to centrifugal radiation.

Colour in alcohol, a bleached yellowish white, the disk with a slightly brown shade.

Localities.—Station 205. West of the Island of Luzon, Philippine group. November 13, 1874. Lat. 16° 42′ 0″ N., long. 119° 22′ 0″ E. Depth 1050 fathoms. Blue mud. Bottom temperature 37°·0 Fahr.; surface temperature 82°·0 Fahr.

Station 216. Midway between the Pelew Islands and New Guinea. Feburary 16, 1875. Lat. 2° 46′ 0″ N., long. 133° 58′ 0″ E. Depth 1675 fathoms. Globigerina ooze. Bottom temperature 35°·4 Fahr.; surface temperature 82°·8 Fahr.

Station 198. In the Celebes Sea, between Celebes and Mindanao. October 20, 1874. Lat. 2° 55′ 0″ N., long. 124° 53′ 0″ E. Depth 2150 fathoms. Blue mud. Bottom temperature 38°·9 Fahr.; surface temperature 85°·0 Fahr.

Remarks.—*Freyella echinata* is readily distinguished from *Freyella pennata* by the small papillate spinulation of the disk, and the spinelets sheathed with membrane crowded with pedicellariæ on the ovarial region. In *Freyella echinata* the rays are somewhat shorter in relation to the disk, but still more delicate, and have a different character, the lateral spinelets being longer and finer. In the armature of the adambulacral plates the inner or furrow spine is always solitary, and the armature of the mouth-plates is in like manner simpler. The madreporiform body is large and conspicuous, whereas in *Freyella pennata* it is hidden. The pedicellariæ are of larger size.

4. *Freyella fragilissima*, n. sp. (Pl. CXIII. figs. 1–4).

Rays eleven. $R = 265$ mm.; $r = 10$ mm. $R > 26\,r$. Breadth of a ray at the base, 5 mm.; the greatest breadth of a normal ovarial inflation, 8·5 mm. (which is situated at about 10 mm. from the disk); and the greatest breadth of the largest inflation, 16·5 mm. At 40 mm. beyond the disk the width of the ray is 4·25 mm.

Rays very long and narrow, narrow and cylindrical at the base but rapidly swelling into a robust and tumidly fusiform ovarial inflation, which contracts more gradually and terminates at about 30 mm. from the disk, thus occupying less than the proximal ninth of the length. The ovarial inflations show various degrees of tumidity in different rays of the same animal, and frequently one is much larger than any of the others, being two or three times the size, and oviform or pyriform in shape. Beyond the ovarial region the ray is subtriangular, with a truncate median carination, and tapers gradually to a very attenuate extremity. In consequence of the number and breadth of the rays, the interbrachial arcs have the form of sharply defined clefts.

The disk is small, with the abactinal surface subplane, and perhaps capable of faint inflation. It is very slightly above the level of the extreme basal part of the rays, towards which the margin of the disk slopes gradually; when viewed in longitudinal profile, the ovarial tumidity is seen to be considerable on the abactinal outline, but not so great as laterally. The abactinal surface of the disk and of the rays, as far as the extent of the ovarial region, is covered with small imbricating subhexagonal plates, overlaid with membranous tissue, and the major diameter of the plates lies transverse to the axis of the ray. Each plate bears a number of very small spinelets about 0·366 mm. in length, covered with simple membrane, which give a velvety or subhirsute appearance to the parts they cover. Upon the disk no definite order of disposition is presented, but upon the ovarial regions somewhat of a grouped arrangement may be often seen, in which a tendency to a transverse lineal disposition may usually be more or less clearly distinguished. These almost microscopic spinelets are articulated on small granules upon the plates. At first sight it might be said that no pedicellariæ were present on the abactinal area of the disk and ovarial regions, but occasionally at wide intervals apart very small isolated sessile pedicellariæ may be found amongst the spinelets on the plates, and usually most frequently near the lateral margin of the ray. Beyond the ovarial region the abactinal surface of the ray is covered with delicate membrane, upon which saddle-like, narrow saccular bands occur, corresponding normally to each ambulacral segment of the ray; numerous very small pedicellariæ are borne upon these sacculi, but they do not appear in the specimens under notice to have that crowded character observed in other species, and they seem usually most frequent on the margins of the sacculi, but whether their absence from the median part is natural, or owing to abrasion, I am unable to say. In this species very little of the abactinal membrane of the ray is preserved intact, and the specimens, which appear to be more fragile than usual, have suffered much damage in the process of disentanglement from the tangles. Where the compact plating of the ovarial region ceases there follows some delicate subcuticular plating in transverse bands, suggesting the character of the succeeding transverse sacculi above noted.

The ambulacral furrow occupies the greater part of the actinal surface of the ray, and measures 2·5 mm. at a place where the ray is 4 mm. The adambulacral plates are longer

than broad, but are relatively shorter than in many species of *Freyella* and *Brisinga*. They measure 1·5 mm. in length at about 70 mm. from the disk, and form a robust-looking margin to the furrow. They are narrower midway between their extremities, and the furrow-margin of the plate is the most incurved, though the concavity is by no means great. The adambulacral armature consists of :—(1.) a small inner spinelet directed over the furrow ; (2.) a large perpendicular spine on the actinal surface ; and (3.) a lateral spine, normally on alternate plates. The small inner spine is attached to the extreme aboral end of the furrow-margin of the plate, and is directed nearly horizontally over the furrow, and at a slight angle forwards ; it is about 1 mm. in length, and is covered with a delicate and rather loose membranous sheath somewhat saccular at the extremity, and bearing a number of very small pedicellariæ near the distal extremity chiefly. The perpendicular spines are about 4 mm. in length at 35 mm. from the disk, and articulated on a prominent tubercle rather away from the centre of the actinal surface of the plate towards the aboral extremity ; they are encased in a delicate semitransparent membranous sheath, covered with great numbers of very small pedicellariæ, but scarcely so crowded as in some species ; the sheath is more or less prolonged at the extremity and a slight saccular expansion is present there. The lateral spine, like the foregoing, appears to be articulated on a prominent tubercle, but it is in reality a rudimentary infero-marginal plate ankylosed on the lateral surface of the adambulacral plate and nearer the aboral end than the middle. The spine is very delicate and needle-like, 11 mm. in length at about 50 mm. from the disk, and 13 mm. at 75 mm., and the longest, a little further outward, is less than 1 mm. more ; it is encased in a delicate membranous sheath, on which are crowded very minute pedicellariæ, but scarcely so numerous as in other species ; the extremity of the sheath is slightly prolonged and saccular. The character of the spinulation of the ray as a whole may be said to be comparatively short and delicate, and the spines appear to be much more numerous and more closely placed than in many others in consequence of the relative shortness of the ambulacral segments. Respecting these latter it may be here remarked that the part of the ambulacral plate which unites with the companion plate and forms the prominent keel along the median abactinal aspect of the ray is strikingly vertebra-like in form, the median portion being deeply incurved, with the adoral and aboral extremities of this surface higher and more prominent than usual in other species.

The actinostome occupies nearly the whole of the actinal area of the disk, its diameter being 13 mm. in a disk 19 to 20 mm. in diameter. The buccal membrane is thick and opaque, and remarkable for its surface being covered with papilliform villous appendages, rather widely spaced, nearly as long as the spinelets on the abactinal surface, and with slightly claviform extremities. They are of unequal size, however, and the largest are near the margin of the mouth. The mouth-plates are small and very insignificant. The united pair are subquadrate in form, the adoral margin being almost straight, the lateral margins straight and slightly converging, causing the adoral margin to be a little less

than the greatest breadth at the aboral extremity. Each plate bears one (or sometimes two) small mouth-spines on the adoral margin. The inner pair are a little removed from the median line of juncture, and are directed horizontally over the buccal membrane parallel to one another; the second pair when present are external to these, and are likewise directed horizontally, but at an angle outward away from the median line prolonged. These spines are about 1·75 mm. in length or rather less, and they are encased in a delicate membrane, on which are numerous small pedicellariæ. A single robust secondary mouth-spine is borne on the actinal surface of each plate; it is about 5 mm. in length, and is encased in a very wide, delicate, saccular, membranous sheath, somewhat expanded at the tip, which gives it a very robust appearance, and the membrane is covered with numerous small pedicellariæ.

The madreporiform body is small, prominently tubercular in form, and situated close to the margin of the disk at the summit of one of the cleft-like interbrachial arcs. The striations are more numerous than in some species of the genus, more or less convoluted, and placed on the side regarding the interbrachial arc. The surface of the plate is quite naked, but the margin is to a certain extent fringed by an indistinct circlet of the spinelets of the dorsal integument. A distinct anal aperture is present conspicuously excentric in position, and the margin of the orifice is bordered by a circlet of spinelets.

Colour in alcohol, a bleached greyish or ashy white.

Localities.—Station 146. Between Marion Island and the Crozet Islands. December 29, 1873. Lat. 46° 46′ 0″ S., long. 45° 31′ 0″ E. Depth 1375 fathoms. Globigerina ooze. Bottom temperature 35°·6 Fahr.; surface temperature 43°·0 Fahr.

Station 156. In the neighbourhood of the pack ice, near the Antarctic Circle. February 26, 1874. Lat. 62° 26′ 0″ S., long. 95° 44′ 0″ E. Depth 1975 fathoms. Diatom ooze. Surface temperature 33°·0 Fahr.

Remarks.—*Freyella fragilissima*, apart from its general habit that is characteristic when once known, may be distinguished from the other species in which the abactinal plates bear small spinelets with simple membrane devoid of pedicellariæ, by the number of its rays, and by the presence of largely developed villous appendages on the buccal membrane.

5. *Freyella bracteata*, n. sp. (Pl. CXIV. figs 1–4).

Rays twelve. R = 210 mm.;[1] r = 12 mm. Breadth of a ray at the base, 5·5 mm.; at the widest part of the ovarial inflation, 8·5 mm. (measured at about 22 mm. from the disk); and at 70 mm. beyond the disk, 4·5 mm.

Rays very long and attenuate, but comparatively robust for the habit of the genus, narrow and irregularly cylindrical at the base, thence gradually swelling into an elongate, irregularly fusiform, ovarial inflation, of small tumidity, which contracts gradually and

[1] Unfortunately all the specimens are more or less broken. I have not been able to find a single entire ray. The above measurement is taken from a smaller example than the type specimen.

terminates at about 45 mm. from the disk, thus occupying less than the proximal fifth of the length. Beyond the ovarial region the ray is subtriangular, with a broadly truncate median carination, and tapers gradually throughout to the extremity. The interbrachial arcs are sharply angular clefts.

The disk is small, with the abactinal surface subplane and higher than the abactinal surface of the rays, the margin sloping rapidly and rather abruptly to the basal part of the rays. The abactinal surface of the disk and of the rays, as far as the ovarial region extends, is covered with imbricating subhexagonal plates overlaid with membranous tissue. The plates are of considerable thickness as compared with other species, and form a much more rigid and firm encasement to the ray than that found in the other forms here described. Upon the disk each plate bears from one to three small stumpy spinelets about 0·45 to 0·57 mm. in length, covered with thin membrane, rather wide apart, and more or less equidistantly spaced, which gives them a rather isolated appearance. On the ovarial regions the plates are often large and irregular in shape, and may bear more spines, the position of which frequently shows a decided tendency to form lineal series on the plates, transverse to the axis of the ray, especially on the lateral parts. Furthermore, these spinelets are in a large measure confined to the median part of the plates, by which means a distinctly marked character of isolated groups is produced. Small, isolated, sessile pedicellariæ are present here and there upon the plates. Beyond the ovarial region the abactinal surface of the ray is covered with delicate, semitransparent membranous tissue, upon which rather broad, saddle-like saccular bands are borne; these bands are continuous across the median keel, and extend to the lateral margin of the ray; their breadth is usually greater than that of the interspace, and their surface is covered with crowded small pedicellariæ. Very delicate incipient plating may here and there be seen underlying the sacculi, either in single plates or two or three together.

The ambulacral furrow is very wide, measuring 3 mm. at a place where the breadth of the ray is 5 mm., and appears to occupy nearly the whole of the actinal surface of the ray. The adambulacral plates are a little longer than broad, and form a narrow cylindrical margin to the furrow. Their length is 1·25 to 1·5 mm. at about 80 mm. from the disk, and their furrow margin is gently concave. The adambulacral armature consists of:—(1.) a small inner spinelet, directed horizontally over the furrow; (2.) a larger and more robust spine, standing perpendicularly on the actinal surface of the plate; and (3.) a still longer lateral spine, borne on alternate plates only. The small inner spine is attached to the extreme aboral end of the furrow margin of the plate, and is directed horizontally over the furrow and at a right angle to the margin; it is about 1 mm. in length, or a trifle more, and is covered with a delicate membranous sheath, which is usually expanded bag-like on the side towards the furrow, resembling a "La Crosse" racquet, and the membrane bears numerous minute pedicellariæ. The corresponding spinelets on the opposite sides of the ray overlap slightly and thus form a straight partition which separates consecutive pairs of ambulacral

tube-feet. It would seem probable that the function of the numerous pedicellariæ on the sacculi of these spinelets was mainly, if not wholly, that of keeping the tube-feet clean. The actinal spinelet is about 5 mm. in length at 60 mm. from the disk, and is articulated on a robust tubercle, which occupies most of the actinal surface of the plate between the middle and the adoral end. It is encased in a delicate membranous sheath, crowded with very small pedicellariæ. The lateral spines are not remarkable for their length, being about 9 to 10 mm. at 70 to 80 mm. from the disk; they are articulated on a tubercle-like rudimentary infero-marginal plate ankylosed on the lateral margin of the adambulacral plate, in a line with the tubercle on the actinal surface, and are rather robust at the base, but taper to a fine extremity, and they are encased in a delicate membranous sheath crowded with small pedicellariæ.

The actinostome is of great width, its diameter being 13 mm. in a disk measuring 23 mm. The buccal membrane is thick and opaque, and the margin of the mouth is beset with a closely crowded villous fimbriation (? probably an exposure of the internal surface). The mouth-plates are small and inconspicuous, somewhat in the form of a truncate wedge, the adoral margin of the pair presenting only a slightly convex margin. Each plate bears two small mouth-spines about 1 mm. in length; the inner pair are a little removed from the median line of juncture, and are directed horizontally over the buccal membrane, usually parallel to one another, or only slightly divergent; the second pair are at the extreme edge of the adoral margin of the plates, *i.e.*, one spine on each plate, and are directed horizontally at a right angle to the median interradial line, and in such a manner that with the corresponding spine of the neighbouring mouth-angle a bar is formed across the ambulacral furrow at the margin of the actinostome. Both the mouth-spines are encased in a delicate membranous sheath, that of the inner pair being wide and bag-like, usually expanded at the tip and pyriform, and numerous small pedicellariæ are borne upon the membrane. The outer pair of spinelets which cross the furrow have the appearance of being imbedded in the actinostomial membrane, and their presence is only detected by the pedicellariæ. A robust secondary mouth-spine is placed well back on the actinal surface of each plate, articulated on a tubercular eminence, and encased in a rather wide, delicate, membranous sheath crowded with pedicellariæ.

The madreporiform body is small, about 2·5 mm. in diameter, convex, subtubercular, and situated quite at the margin of the abactinal surface of the disk, at the summit of one of the cleft-like interbrachial arcs, its position in relation to the plane of the abactinal surface being slightly oblique. Its surface is marked with a few highly convoluted striation-furrows, and the margin is surrounded by an indistinct circlet of the abactinal tegumentary spinelets. A very distinct anal aperture is present; it is excentric in position, and the margin is surrounded with rather larger spinelets than elsewhere upon the disk, and a retracted tubular structure with punctured extremity may be seen within its periphery.

Colour in alcohol, a bleached yellowish white.

Localities.—Station 46. Off the coast of North America, east of New Jersey. May 6, 1873. Lat. 40° 17′ 0″ N., long. 66° 48′ 0″ W. Depth 1350 fathoms. Blue mud. Bottom temperature 37°·2 Fahr.; surface temperature 40°·0 Fahr.

Station 47. Off the coast of North America, east of Massachusetts. May 7, 1873. Lat. 41° 14′ 0″ N., long. 65° 45′ 0″ W. Depth 1340 fathoms. Blue mud. Surface temperature 42°·0 Fahr.

Station 50. South of Halifax, Nova Scotia. May 21, 1873. Lat. 42° 8′ 0″ N., long. 63° 39′ 0″ W. Depth 1250 fathoms. Blue mud. Bottom temperature 38°·0 Fahr.; surface temperature 45°·0 Fahr.

Remarks.—*Freyella bracteata* is distinguished by the number of its rays, by their comparative rigidity, by the proportionally short and robust lateral spines, by the character and the small number of the spinelets on the abactinal plates, and by the character of the armature of the mouth-plates.

6. *Freyella dimorpha*, n. sp. (Pl. CXV. figs. 1–5).

Rays twelve. R = 250 mm.; r = 10 mm. R = 25 r. Breadth of a ray at the base, 4·7 mm.; at the widest part of the ovarial inflation, 8 to 9 mm. (measured at about 16 mm. from the disk); at 50 mm. from the disk the breadth is 3·25 mm.; and at about midway between the extremities, 2·5 mm.

Rays very long and delicate, narrow and cylindrical at the base, and immediately swelling gradually into an elongately oval or subfusiform ovarial inflation, the tumidity of which is not great, and is of nearly the same dimension for some distance along the median part of the region; it contracts gradually outwardly and terminates at about 30 to 32 mm. from the disk, thus occupying about the proximal eighth of the length. Beyond the ovarial region, the ray is subtriangular, with a truncate median carination, and tapers gradually to the extremity. The interbrachial arcs are simple clefts.

The disk is small, with the abactinal surface subplane and probably capable of slight inflation; it is on a higher level than the abactinal surface of the rays, and the margin is sharply rounded and passes towards the basal part of the rays almost precipitously. The abactinal surface of the disk and of the rays as far as the ovarial region extends is covered with imbricating, subhexagonal plates, overlaid with a delicate membranous tissue. The plates are thin, but often comparatively large, and their greater diameter lies transverse to the direction of the ray. Each plate bears from five to ten (usually about half a dozen) very minute spinelets, from 0·35 to 0·45 mm. in length, covered with simple membrane and articulated on small miliary tubercles. The spinelets have a tendency to form lineal series along the major, transverse, diameter of the plates, especially on the lateral regions. Isolated sessile pedicellariæ are to be found here and there upon the plates, though in some examples they appear to be wanting altogether. The disk has a

finely papillate character, the spinelets being uniformly distributed, whilst on the ovarial regions they are grouped. In some examples, plates here and there bear one longer spine (1·5 to 2 mm.) encased in a membranous sheath crowded with very small pedicellariæ, resembling the characteristic spines on *Freyella echinata;* they are, however, wide apart and erratic in their occurrence, but are usually most numerous on the outer part of the ovarial region. Some specimens in the collection show no trace whatever of these spines. In those which have the spines the ovarial regions appear to be slightly more tumid and shorter; perhaps this may be a sexual character. Beyond the ovarial region the abactinal surface of the ray is covered with delicate, semitransparent membranous tissue, upon which broad saddle-like bands are borne, crowded with small pedicellariæ. The bands appear broader than usual, and are continuous over the keel.

The ambulacral furrow is wide, measuring 2 mm. at a part where the ray is 3·5 mm. The adambulacral plates are broader than long, and measure about 1·25 mm. at 45 mm. from the disk. The furrow-margin is slightly concave. The adambulacral armature consists of:—(1.) a small inner spinelet, directed horizontally over the furrow; (2.) a larger and more robust spine, standing perpendicularly on the actinal surface of the plate; and (3.) a still longer lateral spine, borne on alternate plates only. The small inner spinelet is attached to the extreme aboral end of the furrow-margin of the plate, and is directed horizontally over the furrow at a right angle to the margin. It is about 1 mm. in length and is covered with a delicate membranous sheath, expanded at the tip, and bearing several small pedicellariæ. The actinal spine is about 5 mm. in length at 50 mm. from the disk, and is articulated on a prominent tubercle near the aboral extremity of the plate; it is covered with a very delicate membrane, developing a saccular prolongation at the tip, and bearing crowds of very small pedicellariæ. Towards the middle of the ray the spines increase somewhat in size, but often appear much larger in consequence of the greater prolongation of the sheath. The lateral spines, which are articulated on a rudimentary infero-marginal plate ankylosed to the adambulacral plate, are of great length in proportion to the length of the ray, and are of extreme delicacy. At about midway along the ray they measure 22 to 25 mm., and so great is the delicacy of the shaft and of the investing membrane that their appearance is more that of hair-like threads than anything else; they are also very numerous and close together in consequence of the comparative shortness of the ray-segments. There is a more or less extensive prolongation of the sheath at the tip, and a bulbous sacculus is developed. The pedicellariæ which are attached to the membrane are extremely small and are borne on long stalks. The delicacy of the lateral spines taken in conjunction with their length is greater than in the majority of species and is very striking, especially when compared with the apparent robustness of the investment of the actinal spines on the inner part of the ray.

The actinostome is about 12 mm. in diameter in a disk which measures 20 mm. The buccal membrane is rather thick, smooth, and strongly muscular at the actual mouth-

margin. The mouth-plates are small and inconspicuous, and each plate bears on its adoral margin two small mouth-spines. The inner pair are directed horizontally over the buccal membrane and are parallel to one another and the median interradial line; the outer pair, which are at the outer extremity of the adoral margin of the plates, are likewise directed horizontally over the buccal membrane, but outward, forming an angle of about 45° to the inner mouth-spine. These marginal mouth-spines are less than 1 mm. in length, are covered with delicate membrane, and bear at the tip a number of small pedicellariæ. Each plate bears on its actinal surface a secondary or superficial mouth-spine, about 5 mm. in length, articulated on a prominent tubercle, and encased in a membranous sheath bearing large pedicellariæ.

The madreporiform body is small, convex, subtubercular, situated very near the abactinal margin of the disk; its surface is marked with but few, widely-spaced, striation-furrows. A distinct anal aperture is present, and its position is excentric.

Colour in alcohol, a bleached yellowish ashy grey, with a slight tendency to a light brownish shade, especially on the ovarial regions.

Locality.—Station 184. Off Torres Strait, Pacific side. August 29, 1874. Lat. 12° 8′ 0″ S., long. 145° 10′ 0″ E. Depth 1400 fathoms. Globigerina ooze. Bottom temperature 36°·0 Fahr.; surface temperature 77°·5 Fahr.

Remarks.—This species is nearly related to *Freyella echinata*, of which the echinulate forms might easily be considered at first sight as a variety. The general habit, however, of the two starfishes is different in many respects, notwithstanding their apparent nearness in several points of numerical formula, and when the unarmed forms are had in view there is very little in their superficial aspect that would recall *Freyella echinata*. In *Freyella dimorpha* the number of rays is twelve, and this appears to be fairly constant, whereas in *Freyella echinata* there are usually eleven. In *Freyella dimorpha* they are proportionately longer as well as more delicate and attenuate, whilst the ovarial regions are of less extent. The numerous small spinelets on the abactinal plated area are quite different from the armature of those plates in *Freyella echinata*. In *Freyella dimorpha* the lateral spines are considerably longer, although the species is relatively smaller, and their delicacy is exceptional. In this form the true or marginal mouth-spines are small, and their membranous investment as well as the grouping of the pedicellariæ thereon is different. The saddle-like sacculi upon the abactinal membrane of the ray beyond the ovarial region are broader and also maintain their breadth across the median abactinal keel.

Although these differences may appear small in description, they represent variations of character which I find to be fairly constant in species, and on these grounds I have considered the forms under notice as worthy of separate recognition. The dimorphous character of this species, some forms being echinulate and others not, is remarkable. The species also presents some resemblance, perhaps mimetic, to *Freyella fragilissima* and *Freyella bracteata*.

In this species the rays enclosed some masses of a sponge, as if for purposes of food, and I found several pieces of the same held apparently by the actinal spines on the inner part of the rays, which perhaps warrants the inference that the numerous large pedicellariæ there may help in the securing of food and in directing it towards the mouth.

The general habit of this species in its present state is worthy of notice, as different from that of any of the other species. It is not unsuggestive of a *Comatula* or crinoid with its rays drawn together. The rays in the case of the *Freyella* being bent at a right angle to the plane of the abactinal surface of the disk, entirely enclose the actinal area of the disk and rays, which gives a very elegant and remarkable appearance, altogether unusual for a starfish. Whether this disposition is due to the contraction attendant on death, or whether it was one naturally assumed on occasion during life, I am unable to say. All the examples of this species, both the echinulate and the unarmed forms, are unlike in this respect.

7. *Freyella remex*, n. sp. (Pl. CXVI. figs. 1–3).

Rays ten. $R = 450$ mm.; $r = 14$ mm. $R > 32\,r$. Breadth of a ray at the base, 7·5 mm.; the greatest breadth of the ovarial inflation, 11 to 12 mm. (which is situated at about 12 mm. from the disk); the breadth at 30 mm. from the disk is 6 mm., at 50 mm. from the disk, 5·5 mm.; and at about midway on the ray, 4·25 mm.

Rays very long and attenuate, but rather robust in appearance when compared with other species, narrow at the base, but immediately swelling into a short, tumid, pyriform ovarial inflation, which contracts rather more gradually and terminates at 20 mm. from the disk, thus occupying only the proximal twenty-second of the length. The disparity of the ovarial inflation in different rays is only slight. Beyond the ovarial region the ray is subtriangular, with a broadly truncate median carination, and tapers throughout to a very attenuate extremity. The interbrachial arcs are sharply rounded, and when seen from above show a subpyriform outline consequent on the ovarial tumidity.

The disk is small, with the abactinal surface subplane, and slightly above the level of the base of the rays, towards which the margin passes abruptly with a gentle slope. The abactinal surface of the disk and of the rays, as far as the ovarial regions extend, is covered with a thick membranous tissue, the basement stratum of which contains a number of small irregular disconnected calcareous plates completely hidden from superficial view. These plates are of various shapes and sizes, some oval, some elongate, and others cruciform, and they bear very small microscopic spinelets, from 0·45 to 0·7 mm. in length, which are multiradiate in structure, slightly flaring at the tip, and covered with simple membrane causing the spinelets to appear more or less clavate at the tip. The spinelets are rather wide apart and tolerably equidistantly spaced; no order of disposition is observed,

and the surface presents a finely papillate appearance. A few comparatively large isolated pedicellariæ are present here and there on the general membrane amongst the spinelets. On the outer part of the ovarial region the spinelets cease and their place is taken by pedicellariæ. Beyond this region the ray is covered with a delicate semitransparent membrane, upon which transverse saddle-like saccular bands are borne, crowded with very minute pedicellariæ. The bands extend from one margin of the ray to the other, and are broad and uninterrupted across the median keel of the ray. The breadth of the bands is normally greater than that of the interspaces; they are usually more or less expanded near the margin, and frequently the band there is bent sharply at a right angle and may be prolonged so as to merge into the next succeeding band, and sometimes quite a series are thus united by a longitudinal band running parallel to the margin, especially on the proximal part of the ray. The bands normally correspond to the ambulacral segments of the ray and usually cross the "vertebræ," as seen in the median keel, between the adoral and aboral extremities; their position, however, in this respect is not constant by any means, as they may cross at all intermediate positions, and sometimes pass over the suture uniting two succeeding "vertebræ;" sometimes two succeeding bands are united by a longitudinal prolongation close to the keel, and sometimes a band commencing at one margin of the ray crosses the keel, and then stops abruptly, leaving the other side of the segment without a sacculus.

The ambulacral furrow is of great width, and measures 3·5 mm. at a place where the ray is 5·7 mm. (53 mm. from the disk). The adambulacral plates are slightly longer than broad, measuring 1·75 mm. at about 53 mm. from the disk, and they form a narrow margin to the furrow. The furrow-margin of the plate is slightly incurved. The adambulacral armature consists of:—(1.) a small inner spinelet directed horizontally over the furrow; (2.) an elongate spine articulated on the actinal surface of the plate and standing perpendicularly or directed outwards; and (3.) a lateral spine of great length and delicacy borne on alternate plates only. The small inner spine is attached to the extreme aboral end of the furrow-margin of the plate and lies quite within the furrow, across which it is directed horizontally and slightly forwards; it is about 2 mm. in length, and is of a remarkable shape, being flaring and fan-like in form, and covered with a delicate, semitransparent membrane, more or less saccular, and upon which three or four large isolated pedicellariæ are borne. The plane of the flattened surface is vertical and perpendicular to the axis of the ray. The actinal spines are about 7 mm. in length at 50 mm. from the disk, and are articulated on a tubercle situated on the actinal surface of the plate close to its aboral end; they are encased in a delicate, semitransparent membranous sheath crowded with great numbers of very minute pedicellariæ, and with a saccular prolongation at the tip. On the inner part of the ray, for about 40 mm. from the disk, these spines are slightly expanded at the tip, but still remain cylindrical, and are truncate and often calicular; the membranous sheath does not cover this flaring tip, but terminates beneath

it after a slight bulbous inflation. Further out on the ray the spines are very delicate, tapering, and sharply pointed, with the sheath more or less prolonged and a bulbous saccular expansion developed. At about the median third of the ray, the actinal spines on alternate plates are of different sizes, the plates which bear the lateral spine having a much shorter actinal spine than the others. Thus at 130 mm. from the disk the short spines are 6 mm. and the alternating long ones 10 mm.; at 200 mm. from the disk (in another ray), the alternating spines are 3 mm. and 10 mm. respectively, and on another 2·5 mm. and 9 mm. respectively at about the same distance. The lateral spine is articulated on a prominent tubercle-like rudimentary infero-marginal plate ankylosed on the lateral surface of the adambulacral plate. It is remarkable for its great length and delicacy, the longest spines, which are situated at about 160 to 180 mm. from the disk, measuring 35 mm.; close to the ovarial region they are short, not more than 7 mm., but at 70 to 80 mm. from the disk they are 20 mm., and at 100 mm. from the disk 28 mm., and they increase as they proceed outward to the measure above indicated, and again diminish as they approach the extremity of the ray. The lateral spines, like the actinal spines, are encased in a very delicate, semitransparent membranous sheath, crowded with minute pedicellariæ. These spines are extremely thin and delicate, and the invested shaft does not measure more than 0·216 mm. in thickness on the average. At the proximal extremity of the spines the membrane is seen to be contracted to the rim of the articulatory head of the spine, and is not continued as a uniformly broad sheath upon the tubercle; at the distal extremity the sheath is slightly prolonged and a bulbous sacculus is developed.

The actinostome occupies about half the actinal surface of the disk, its diameter being 14·5 mm. in a disk measuring 28·5 mm. The buccal membrane is thick and opaque. The mouth-plates are small and quite inconspicuous; the united pair have somewhat the form of a truncate wedge, the adoral margin being almost straight and with scarcely any prominence into the actinostome. The true mouth-spines are aborted, often absent altogether, but in some instances rudiments are present; when this is the case the spinelets of the inner pair, which are very minute, are close together and enveloped in one common membranous sheath, the whole having the appearance of a little oviform scale pressed close against the mouth-plates; the outer pair, when present, are buried in the actinostomial membrane and appear to be merged in the ambulacral bar which crosses the furrow at the actinostome; their individuality is lost and usually no trace can be found of them. No pedicellariæ are borne upon the rudimentary mouth-spines. Each mouth-plate bears one large robust secondary mouth-spine on its actinal surface, away from the adoral margin. There is thus a pair to each mouth-angle, and they are the only true spines present. The spines are 5 mm. in length, flattened at the tip, and slightly flaring, the flattened extremity being sometimes bifurcate. The shaft is encased in a delicate, semitransparent,

saccular, membranous sheath, upon which are a few isolated and comparatively large pedicellariæ.

The madreporiform body is rather small and elongately oval, slightly convex, and with the surrounding parts somewhat prominent; the surface is traversed with tolerably numerous, slightly convoluted, striation-furrows, the main direction of which corresponds to the major diameter. A very distinct anal aperture is present in an excentric position, and within its periphery the termination of a punctured (?) tube may be seen.

Colour in alcohol, a bleached ashy yellowish white.

Locality.—Station 181. In the Coral Sea, south-east of New Guinea. August 25, 1874. Lat. 13° 50′ 0″ S., long. 151° 49′ 0″ E. Depth 2440 fathoms. Red clay. Bottom temperature 35°·8 Fahr.; surface temperature 80°·0 Fahr.

Remarks.—This species is perhaps the most handsome member of the group. It is distinguished from all other forms by the long delicate lateral spines, by the peculiar aborted character of the mouth-spines, by the rudimentary nature of the abactinal plating, as well as by a number of minor details which it is unnecessary to recapitulate.

8. *Freyella tuberculata*, n. sp. (Pl. CXVII. figs. 1–3).

Rays six. R = 240 mm.; r = 6 mm. R = 40 r. Breadth of a ray at the base 4 mm.; at the widest part of the ovarial inflation, 5 mm. (measured at 15 mm. from the disk); and at 80 mm. beyond the disk, 2·60 mm.

Rays of great length and delicacy, cylindrical at the base, gradually swelling at a short distance from the disk into a very slightly fusiform ovarial inflation, which as gradually contracts, and the ray thence becomes subtriangular and tapers continuously to a very attenuate extremity. The ovarial region extends for about 30 mm. from the disk, *i.e.* about the proximal eighth of the ray. The rays have a well-spaced appearance at the base, for this genus, and the interbrachial arc is sharply rounded.

The disk is small and its abactinal surface is flush with that of the rays at the base; it was probably capable of slight inflation, but there is in its present state a faint depression within the periphery of the perisomatic ring. The abactinal area of the disk and of the rays, even for some distance beyond the ovarial inflation, is covered with small hexagonal plates, overlaid with the most delicate membrane. On the ovarial region the plates are larger than elsewhere and their major diameter lies parallel to the axis of the ray. Each plate bears centrally a small rounded tubercle, on which is articulated a short, delicate, tapering, and sharply pointed spinelet, about 1·25 mm. in length on the disk; these are encased in a very delicate membranous sheath, upon which are crowded minute pedicellariæ. A number of the spinelets on the disk and nearly all those on the ovarial regions are now devoid of membrane, probably accidentally on account of

its extreme delicacy, and for this reason I am unable to say whether the pedicellariæ were present to the same extent on the spinelets of the ovarial regions as on those of the disk. The plating does not terminate with the ovarial regions, but is continued along the ray, the plates, however, becoming much smaller and more delicate. I have traced it considerably beyond the middle of the ray, and isolated plates with single spines occur up to the extremity. It is only on the outer part that I have been able to find any traces of the groups of pedicellariæ, comparable to those on the saddle-like sacculi, which are so conspicuous in other species. Certainly none are present where the plating is continuous. The groups here noted are circular in form, placed near the lateral margin of the ray, and the pedicellariæ are extremely small.

The ambulacral furrow is broad, and has a singular appearance, simulating rather suggestively a lineal series of confluent keyhole-shaped apertures, in consequence of the formation of the adambulacral plates about to be noticed. The adambulacral plates are elongate (2·5 mm. in length at 80 mm. from the disk), very like vertebræ in form, with their furrow-margin deeply incurved. This scooping out of the margin does not commence immediately at the adoral end of the plate, but rather abruptly a little way beyond; it is continued, however, up to the extreme aboral end, and the latter, in consequence of the depth of the concavity, has the appearance of being produced at an angle horizontally into the furrow; a keyhole-shaped outline is thus produced, and the width of the furrow is obviously much narrower when measured between the thick adoral portions of the adambulacral plates than across the deepest part of the incurvature, the breadth in one case being less than 1 mm., and in the other fully 2 mm., at a part where the width of the ray is 3·6 mm. The successive pairs of ambulacral tube-feet have thus a widely spaced and isolated appearance. The armature of the adambulacral plates is very simple, and consists of only one very delicate spinelet which stands perpendicularly, and an equally delicate lateral spine, articulated on a rudimentary ankylosed infero-marginal plate, usually on every alternate plate. The small inner spinelet at the aboral extremity of the furrow-margin of the plate, which is present in most species, is here wanting altogether. The perpendicular spinelet measures about 4 mm., but frequently less, and is articulated on a small tubercle situated on the actinal surface of the plate at its narrowest part, and consequently in a line with the pair of ambulacral tube-feet and nearer the aboral than the adoral extremity of the plate. It is encased in a delicate membranous sheath crowded with pedicellariæ. The lateral spinelets are of very great delicacy, about 7 mm. in length at 150 mm. from the base, and like the perpendicular spinelets are encased in a delicate membranous sheath with crowded pedicellariæ. So great is the delicacy of both perpendicular and lateral spines alike that very few can be found undamaged.

The actinostome is wide, its diameter being 6·75 mm. in a disk measuring 12·5 mm. The buccal membrane is semitransparent and permits the plications of the digestive cavity to be seen. The mouth orifice is small, and its margin is much crenulated, the

muscular system being strongly developed. The mouth-plates are small and remarkable for their simplicity and for the small amount of modification which the primitive constituent parts have undergone. The mouth-plates are distinctly seen to be adambulacral plates slightly altered in form and proportions; they are elongate and subtriangular, and extend from the margin of the actinostome to the interbrachial arc, occupying the whole of the breadth of the buccal ring (Sars' term). The adoral ends are truncate, and the united pair have consequently a subhexagonal form, the median suture is wide and distinct, and more or less open outwardly. Each plate bears only two delicate spines, one close to the adoral margin and away from the median line of juncture, directed horizontally over the actinostome, the spines on two companion mouth-plates being parallel to one another. The other spine borne on the plate is a secondary or superficial mouth-spine, and is placed midway on the surface of the plate opposite the lateral angle. Both these spines are articulated on small tubercles; they are of nearly equal size, about 1·75 mm. in length, and are encased in delicate membranous sheaths, crowded with pedicellariæ. The adambulacral plate adjacent to the mouth-plates is very short, its breadth being greater than its length; in the next outward, these dimensions are about equal, and beyond this the length exceeds the breadth in increasing proportion.

The madreporiform body is small, prominent, subtubercular, naked, with two or three very simple angulated furrows (in place of striations), and is situated close to the margin of the disk; it is not exactly in the median interradial line, but a little to one side, and consequently not immediately above the "odontophore." The latter plate is large, conspicuous externally, shield-shaped, and placed on the slope or bevel which intervenes between the plane of the abactinal surface and the extreme margin.

Colour in alcohol, a bleached greyish white, with a faint pinkish shade over the ovarial regions.

Localities.—Station 89. Between the Canary Islands and Cape Verde Islands. July 23, 1873. Lat. 22° 18′ 0″ N., long. 22° 2′ 0″ W. Depth 2400 fathoms. Globigerina ooze. Bottom temperature 36°·6 Fahr.; surface temperature 73°·5 Fahr.

Station 346. Between the coast of Africa and the Island of Ascension. April 6, 1876. Lat. 2° 42′ 0″ S., long. 14° 41′ 0″ W. Depth 2350 fathoms. Globigerina ooze. Bottom temperature 34°·0 Fahr.; surface temperature 82°·7 Fahr.

Remarks.—This species is remarkable in many respects, and very distinct from other forms. The small size of the disk in relation to the great length of the ray, the extent over which the plating is carried, the size of the plates and their unispinulate armature, the form of the adambulacral plates, the simplicity of their armature with the absence of the inner or furrow-margin spine, the corresponding simplicity of the mouth-plates, and finally the prominence of the odontophores and their unusual position, are a list of characters which do not occur in any of the other forms of *Freyella* or *Brisinga*, and cause this species to stand out with striking distinctness.

9. *Freyella benthophila*, n. sp. (Pl. CXI. figs. 5–8).

Rays six. R = 88 mm.; r = 3 mm. R = 30 r, approximately. Breadth of a ray at the base, 2·5 mm.; at 10 mm. from the disk, 1·75 mm.; and at about midway between the base and the extremity, 1 mm.

Rays very long, extremely delicate and attenuate, cylindrical at the base, very slightly inflated in the ovarial regions, which extend about 10 mm. from the disk, or occupy the proximal ninth of the ray; beyond this the ray is subtriangular with a truncate carination, and tapers continuously to a very attenuate extremity. The interbrachial arcs, though sharply rounded, have somewhat of an angular character.

The disk is small, with the abactinal surface slightly subconically convex, and higher than the abactinal surface of the rays, the outline when seen in profile passing with a gentle slope towards and along the ray, the interference of the ovarial inflation being very slight. The abactinal area of the disk and of the ovarial regions is covered with very delicate calcareous plates overlaid with extremely delicate membrane. The plates bear two or three short, rather stumpy but very minute, spinelets (quite microscopic), and a number of small distributed pedicellariæ, the whole having more or less of a grouped appearance on each plate. On the outer part of the ovarial regions the microscopic spinelets frequently appear to be less numerous. The plating does not extend beyond the ovarial region, and from thence to the extremity the abactinal surface of the ray is covered with an extremely delicate semitransparent membrane. Small pedicellariæ are distributed over the membrane and, though numerous, have a comparatively widely spaced appearance; they are most numerous towards the lateral margin, and may to a certain extent be said to occur in patches corresponding to the "vertebræ" of the ray, but do not approach the character of the aggregated groups on the saddle-like sacculi noticed in other species.

The ambulacral furrow is broad and occupies nearly the whole of the actinal surface of the ray, the adambulacral plates forming only a narrow margin; its width is about 1 mm. where the ray is 1·75 mm. The adambulacral plates are elongate, 1·3 mm. in length at 10 to 12 mm. from the disk, and measure the same quite close to the extremity, where the length appears relatively greatly emphasised in consequence of their narrowness and attenuation. The plates are very narrow midway between their extremities, their outline being distinctly concave; the furrow-margin is the most incurved, and the outline of the furrow has consequently the appearance of a lineal series of confluent ovals. The armature of the adambulacral plates consists of a single very delicate spine articulated on a small tubercular prominence on the middle of the actinal surface midway between the extremities, and an equally delicate lateral spine, often of the same length but normally slightly longer, articulated on a rudimentary infero-marginal plate ankylosed on the lateral wall immediately beneath the spine just mentioned, usually on alternate plates, but sometimes less frequently. These spines are enclosed in delicate membranous sheaths with

crowded pedicellariæ. The length of the longest is about 2 mm., and their delicacy is so great that when denuded of the membranous sheath, they are almost invisible to the naked eye. The actinal spines do not perhaps generally stand perpendicularly, but are directed laterally at a small angle to the horizontal, the plane of the direction of these spines almost coinciding with that of the lateral spines, with which at first sight they might almost be ranked. No inner spinelet of any kind is present on the furrow-margin of the plate.

The actinostome occupies nearly the whole of the actinal surface of the disk, its diameter being 4·5 mm., that of the disk being 6 mm. The buccal membrane is of great delicacy, and perfectly transparent, the folds of the digestive cavity being clearly visible through it. The mouth-plates are small and rather elongate, extending from the margin of the actinostome to the interbrachial arc, the united pair having a subhexagonal outline. The actinostomial margin of the plates is comparatively broad and straight, with the faintest prominence at the median line of juncture. Each plate bears one or sometimes two small short mouth-spines, 0·36 mm. in length, on the adoral margin away from the median line, directed horizontally over the actinostome, but at an angle to the median interradial line; when two mouth-spines are present the outer one is at angle of about 45°, and the inner one less than this. These mouth-spines can also be directed perpendicularly. Both are covered with thin opaque membrane, but bear no pedicellariæ. On the actinal surface of each plate, midway between the extremities, is a comparatively large secondary or superficial mouth-spine, 1·7 mm. in length, encased in a delicate semitransparent membranous sheath crowded with pedicellariæ. The sheath appears to terminate abruptly at a little distance from the tip of the spine; moreover, the pedicellariæ seem to be most numerous on the trumpet-shaped edge of the roll, and none are present on the basal part of the sheath; indeed, I am inclined to think that this disposition of the pedicellariæ upon the sheaths obtained throughout the ray. The secondary mouth-spines are twice as thick and robust as any of the other spinelets on the ray.

The plate which I regard as the madreporiform body has a very peculiar appearance, it is placed quite at the margin of the abactinal surface of the disk, is subtubercular, and with somewhat of a conchoidal form, having a single suture or "striation" furrow, resembling the lip of certain volute shells, passing across it. The naked portion of the plate bears three or four short spinelets and a few pedicellariæ, the same as the other dermal structures of the disk, above noted. The whole structure (if this indeed be the madreporiform body) looks more like two displaced impinging plates than anything else. A distinct anal aperture is present and its position is slightly excentric.

Colour in alcohol, greyish white, with a faint pinkish shade over the ovarial regions.

Locality.—Station 289. In the Mid-South Pacific, near the meridian of 130° W. October 23, 1875. Lat. 39° 41′ 0″ S., long. 131° 23′ 0″ W. Depth 2550 fathoms. Red clay. Bottom temperature 34°·8 Fahr.; surface temperature 54°·5 Fahr.

Remarks.—*Freyella benthophila* is characterised by the presence of six rays, a number

possessed by only two other forms, *Freyella tuberculata* and *Freyella sexradiata*. It may be distinguished from both of these by the spinulation of the abactinal plates, each plate bearing two or three small spinelets covered with simple membrane devoid of pedicellariæ. The general proportions are also different.

10. *Freyella heroina*, n. sp. (Pl. CXIV. figs. 5–8).

Rays nine. R = 320 mm.; r = 10 mm. R = 32 r. Breadth of a ray at the base, 5·5 mm.; at the widest part of the ovarial inflation, 8·5 mm.; and at 40 mm. beyond the disk, 4·5 mm.

Rays delicate and of remarkable length, cylindrical and narrow at the base, but almost immediately swelling rather abruptly into a short ovoid ovarial inflation of moderate tumidity, which hardly extends beyond 15 mm. from the base of the proximal twenty-first part of the ray. From thence the ray is subtriangular and tapers continuously to the extremity. The rays are distinctly spaced at the base, the interbrachial arcs being sharply rounded.

The disk is small, with the abactinal surface, which is subplane and capable of slight inflation, very little higher than the base of the rays. The membrane covering the disk and the basal portion of the rays, to the limit of the ovarial region, is underlaid by a pavement of calcareous plates of subhexagonal form, which appear rather widely spaced. The plating of the disk is invisible superficially, but that of the ovarial region may be clearly traced with a hand-magnifier. On the disk the plates bear only very small spinelets, about a millimetre in length or rather less, which taper slightly and are covered with simple membrane, and they are sufficiently numerous to give a fairly hirsute appearance to the disk. On the ovarial regions the spinelets are smaller and are congregated in little groups of three to five on the centre of each plate, and the groups have consequently a distinct and isolated appearance when seen with a low power. No pedicellariæ occur normally among the spinelets on the disk and ovarial regions, but here and there a small sporadic one may be found. On the outer (distal) portion of the ovarial swelling, however, the spinelets diminish in number, and their place is taken by small crowded pedicellariæ, which speedily fall into crowded transverse bands, the spinelets disappearing altogether. These pedicellariæ are very small and measure from 0·12 to 0·15 mm. in length. Beyond the ovarial inflation the abactinal surface of the ray is covered with the usual delicate transparent membrane, bearing saddle-like sacccular bands crowded with minute pedicellariæ, the corresponding bands on the two sides of the ray being united across the median keel.

The ambulacral furrow occupies nearly the whole of the actinal surface of the ray, measuring about 2 mm. in width at a part where the whole ray is 4 mm. The adambulacral plates are elongate, nearly 2 mm. in length, and form a narrow rounded margin to the furrow; their form is strikingly suggestive of a caudal vertebra; the adoral end of

the plate is somewhat broader than the aboral, and the margin towards the furrow is rather deeply concave, the greatest depth lying between the median point of the furrow margin and its aboral extremity, where the plate stretches prominently into the furrow, forming a well-defined bay along which the ambulacral tube-foot passes, and by which it is separated from the succeeding tube-foot. The armature of the adambulacral plates consists of:—(1.) a small spinelet attached to the aboral prominence of the plate above-mentioned, and directed horizontally over the furrow and at a slight angle in the direction of the ray; (2.) a longer spine standing perpendicularly and articulated on a tubercular elevation on the middle of the actinal surface of the plate; and (3.) a lateral spine on alternate plates articulated on a tubercle-like rudimentary infero-marginal plate ankylosed on the lateral margin of the adambulacral plate. The small inner spinelet is rather more than a millimetre in length, and comparatively robust at the base; it is often flattened and expanded at the tip, which is truncate and subspatulate, the whole covered with membrane bearing a rather numerous congregation of pedicellariæ. The perpendicular spine is delicate and tapering; the longest are about 5 mm. in length, but at 80 or 90 mm. from the disk they are not more than 2 to 3 mm., and their length generally appears to be rather irregular; they are encased in a membranous sheath, with a more or less elongate saccular prolongation, and the whole is covered with crowded pedicellariæ. On the ovarial region the distal extremity of these spines is usually expanded like the proximal articulatory base, and is truncate, which gives them a robust clavate appearance. The lateral spines are of great delicacy; the longest measure 16 to 18 mm., and they are encased in a sheath of very delicate membrane with crowded pedicellariæ, and there is a comparatively large saccular knob at the extremity. The pedicellariæ are exceedingly small and attached to the membrane by long thread-like stalks. Unfortunately, very few of these spinelets are to be found unbroken, owing to the extreme fragility and delicacy of the specimen, and probably also to the difficulty in detaching it from the hempen tangles. It is much shattered, and I am therefore unable to say with accuracy what the general habit of the ray would be in comparison with that of other species, but I am disposed to think that the lateral spines were relatively short in proportion to the great length of the rays, and that they were certainly more delicate than usual.

The actinostome is large and wide, its diameter being about 12 mm., in a disk measuring 19 mm. The buccal membrane is of great delicacy, and semitransparent. The mouth-plates are small and inconspicuous, and present a remarkably straight margin towards the actinostome. Two small mouth-spines are borne on each plate, of a peculiarly curved, semicrescentic or semiscimitar form; they have the appearance of bending round until the outward prolongation of the distal extremity is at a right angle to the prolongation of the median line of the mouth-plates, and their shortness gives them the appearance of being turned back so as to fit almost close to the margin of the plate. They

are covered with thin membrane, and have a few pedicellariæ near the base. Each plate bears on its actinal surface a secondary or superficial mouth-spine 4 mm. in length, enclosed in a membranous sheath crowded with large pedicellariæ. The entrance of the ambulacral furrow is barred at the actinostomial margin by two broad crescent-shaped processes or plates, which are articulated on the mouth-plates and appear to be the modified representatives of the inner or furrow spine on the adambulacral plates. These plates meet their correspondents in the median radial line and form a noticeable tract separating the first pair of ambulacral tube-feet from the buccal membrane.

The madreporiform body is situated on a distinct prominence, and at the margin of the abactinal surface. The slope of the prominence is covered with membrane and spinelets, in fact a continuation of the dorsal tegumentary structures. The striation is of great simplicity, consisting apparently of only two angulated furrows, one outside the other.

Colour in alcohol, ashy white, with a slight pinkish shade on the side of the ovarial regions, probably owing to the thinness of the plating there.

Locality.—Station 244. In the Mid-North Pacific, between Yeddo and San Francisco, near the meridian of 170° E. June 28, 1875. Lat. 35° 22′ 0″ N., long. 169° 53′ 0″ E. Depth 2900 fathoms. Red clay. Bottom temperature 35°·3 Fahr.; surface temperature 70°·5 Fahr.

Remarks.—This species is remarkable for the great length of the rays and the relatively short ovarial regions. It may be readily distinguished by the number of the rays, by the peculiar subcrescent or scimitar-shaped mouth-spines, by the armature of the adambulacral plates, and by the character of the spinulation of the abactinal plates.

11. *Freyella attenuata*, n. sp. (Pl. CXIII. figs. 5–7).

Disk and number of rays unknown. Breadth of a ray at the base, 2·8 mm.; at the widest part of the ovarial inflation, 3·8 mm. (which is measured at about 5 mm. from the base); and at 33 mm. from the base, 2·1 mm.

Rays elongate, delicate, and slender; subcylindrical at the base, swelling rather rapidly into a small fusiform ovarial inflation, which contracts more gradually outwardly and terminates at about 12 mm. from the base, the ray beyond this point being subtriangular.

The abactinal surface of the ray at the base is covered with very thin but comparatively large subhexagonal plates which bear from one to three short, sharply pointed, minute spinelets, most of the plates on the ovarial region having the larger number and with a tendency to a lineal arrangement on the plate transverse to the axis of the ray. Beyond the ovarial region the plates diminish in size and become irregular, whilst only some of them bear spinelets which are also smaller; isolated minute spinelets may be

traced as far as 28 mm. from the base. The outer part of the ray is covered with a very delicate semitransparent membrane.

The ambulacral furrow is wide and measures 1·6 mm. at a part where the ray is 2·5 mm. The adambulacral plates are remarkable for their length and generally attenuate character. Indeed the same remark applies to the whole ambulacral ossicle or segment, the latter when seen from above having the appearance of two thin cylindrical rods placed side by side. The length of the adambulacral plate is 2·8 mm. at 25 mm. from the base; its furrow-margin is deeply concave, and the outer margin to a less degree, the shape of the plate being that of an elongate phalangial bone considerably constricted in the median region; when seen from the actinal side it has also a slightly angulated or twisted appearance in consequence of the posture and formation of the tubercle upon which the actinal spine is articulated. The plates overlap considerably, the aboral end of one being hollowed out to receive the produced adoral end of the next plate, and a rather wide space between is occupied by ligament. The adambulacral armature consists of:—(1.) a very minute inner spine directed over the furrow, but which is present only on the extreme basal portion of the ray; (2.) a short actinal spine, articulated on a rudimentary infero-marginal plate on the actinal surface of the plate; (3.) a short delicate lateral spine articulated on the lateral margin of each alternate plate. The small inner spine, excepting on the first one or two segments, is quite microscopic, thornlike and sharply pointed, and deeply placed in the furrow, near the aboral extremity of the plate, and covered with membrane, upon which I find no trace of any pedicellariæ. The actinal spine is small, about 2 mm. in length, very delicate, tapering to a sharp point, and encased in a thin membranous sheath, crowded with small pedicellariæ, which develops a rather elongate sacculus at the distal extremity. Notwithstanding its small size this spine has a large expanded condyloid base by which it is articulated on a prominent tubercle situated slightly on the aboral side of the median point of the actinal surface of the adambulacral plate. The lateral spine is extremely delicate, about 6·5 mm. in length, and is encased in a thin membranous sheath, with an elongate saccular extension at the distal extremity, and covered with numerous small pedicellariæ. It resembles the actinal spine in the character of its base, and is articulated on a prominent tubercle-like rudimentary infero-marginal plate, ankylosed on the lateral margin of the adambulacral plate in a line with the tubercle that bears the actinal spine.

Colour in alcohol, a delicate pellucid white, with a fleshy shade on the ovarial region.

Locality.—Station 226. West of the Mariana or Ladrone Islands. March 25, 1875. Lat. 14° 44′ 0″ N., long. 142° 13′ 0″ E. Depth 2300 fathoms. Radiolarian ooze. Bottom temperature 35°·5 Fahr.; surface temperature 79°·0 Fahr.

Remarks.—At first sight I was disposed to think that possibly this might be the young form of *Freyella heroina*, to which it is most nearly allied, but when the extraordinary length and attenuation of the ray segments, greater than that found in any part

of the mature ray of *Freyella heroina*, are taken into consideration, together with the differences in the adambulacral armature and the spinulation of the abactinal plates, I consider it safer on the strength of the material at my disposal to rank the form under notice as a distinct species.

Genus *Colpaster*, n. gen.

Rays elongate and subcylindrical as viewed from above, having the general character of the rays of Brisingidæ. Disk small and sharply defined, the rays being readily detachable.

Abactinal area of the disk and of the basal portion of the rays covered with small, scale-like, imbricating, calcareous plates, which form a compact casement. The plates bear minute isolated spinelets, those upon the disk being slightly larger than on the base of the rays, and with their extremity denticulate. No papulæ are present.

Adambulacral plates only slightly longer than broad, widely spaced, the interspaces being filled with ligament. Adambulacral armature consisting of two small equal inner spinelets, one at each extremity of the furrow-margin, and two unequal spines on the actinal surface of the plate, one large and robust. These are invested with membranous sheaths covered with crowded pedicellariæ. Robust lateral spines are articulated on small rudimentary infero-marginal plates intimately united to the adambulacral plates.

An azygos interradial plate, shield-shaped and conspicuous superficially, separates the first pair of free adambulacral plates, resembling the mouth-shield of an Ophiuran.

Mouth-plates small, with an armature consisting of three mouth-spines proper, and three large secondary or superficial mouth-spines on the actinal surface of each plate.

Madreporiform body small, subtubercular, prominent, situated near the margin of the disk; striations few in number and simple. Anal aperture distinct, situated excentrally.

Remarks.—*Colpaster* resembles *Freyella* in general habit and in the plating of the disk and ovarial regions of the rays. It is distinguished, however, from that and from all other forms by the presence of the azygos interradial plate external to the mouth-plates, and by the character of the armature of the adambulacral plates and mouth-plates.

Chorology of the Genus Colpaster.

α. Geographical distribution:—

Atlantic: One species between the parallels of 20° and 30° N.

Colpaster scutigerula, from south-west of the Canary Islands.

β. Bathymetrical range: 1525 fathoms.

γ. Nature of the Sea-bottom: Hard ground.

Chorological Synopsis of the Species.

	Ocean.	Range in Fathoms.	Nature of the Sea-bottom.
Colpaster scutigerula . .	Atlantic.	1525	Hard ground.

1. *Colpaster scutigerula*, n. sp. (Pl. CXVII. figs. 4–7).

Rays seven. R = ? mm.; r = 6 mm. Breadth of a ray at the base, 5 mm.; at the widest part of the ovarial inflation, 5·5 mm. (measured at 9 mm. from the disk); and at 24 mm. from the disk, 4 mm.

The rays are robust at the base in proportion to the small disk, and have a very slightly fusiform ovarial inflation, which does not extend beyond 18 mm. from the disk. Beyond the ovarial inflation the ray is subtriangular, with a broad median carination.

The disk is small and rather thick, with the lateral walls precipitous, and the margin slightly incurved in the interradia, and slightly tumid over the base of the rays. The abactinal surface is covered with small imbricating plates, which bear from three to six small equal-sized spinelets less than 0·5 mm. in length; their shafts are cylindrical, flaring slightly at the tip, with four or five thornlets. One or two small pedicellariæ may be seen here and there at the base of the spinelets, but there are very few. The abactinal surface of the rays is covered (at least at the base) with similar small imbricating plates, which diminish very considerably in size as soon as the ovarial region is passed. They are present throughout the whole length of the fragments under notice, and I am therefore unable to say how far they extend along the ray. The plates on the ovarial regions bear similar, but rather smaller, spinelets than those on the disk, and they decrease in number on the outer part of the region. Numerous small pedicellariæ are upon the plates and increase in number as the spines decrease, but no trace of sacculi with crowded pedicellariæ are discernible on the innermost 28 mm. of the ray.

The ambulacral furrow is wide, measuring 2·25 mm. in breadth at a part where the ray is 4 mm. The adambulacral plates are very little if at all longer than broad at the outermost end of the fragments, where they measure about 1·3 mm. in length; they are separated by a wide space filled in with ligament, and the furrow-margin of the plate is slightly concave. The adambulacral armature consists of:—(1.) two small inner spines, one at each extremity of the plate, directed over the furrow; (2.) two unequal actinal spines, which stand perpendicularly or slightly inclined towards the furrow; (3.) a lateral spine, perhaps normally borne on alternate plates, but frequently on consecutive plates on the basal part of the ray. The small inner spines, which are subequal, are a trifle more than 1 mm. in length, cylindrical, delicate, and only slightly tapering; they are covered

with delicate membrane bearing a number of small pedicellariæ; the position of the aboral spine is rather high in the furrow, over which it is directed at an angle of about 45°, and at a right angle to the margin. The two actinal spines are very unequal in size, the smaller one, situated close to the aboral end of the plate and a little on the furrow side of the median longitudinal line, is about twice the length of the small inner spine or even rather more, but very much more robust, especially at the base, which is thick, and the shaft tapers to a pointed extremity; it is articulated on a small tubercle and is covered with delicate membrane bearing small pedicellariæ. The adoral companion, which may be considered the true actinal spine, is large and robust, about 4 mm. in length, and is articulated on a tubercular eminence, midway between the extremities of the plate and a little on the outer side of its median longitudinal line. The shaft is thick, cylindrical, and in the eight or ten innermost spines flaring at the extremity, and with its surface marked with comparatively coarse striations, which have often a slightly twisted appearance, and is covered with delicate membrane crowded with pedicellariæ. The lateral spine is long, robust, and tapering, similar in character to the large actinal spine. It is articulated on a prominent tubercle-like rudimentary infero-marginal plate ankylosed on the lateral side of the adambulacral plate, and is covered with delicate membrane with crowded pedicellariæ. The lateral spines are quite remarkable for their robustness in relation to the small size of the disk.

The actinostome is wide, 7·5 mm. in diameter, that of the disk being 12 mm. The mouth-plates are small but powerful, and are remarkable for the number and size of the mouth-spines they bear. On the margin of each plate are three small cylindrical spinelets, two of them in front but away from the median suture, well spaced, radiating apart, and directed horizontally over the buccal membrane, whilst the third is further back and directed across the entrance of the furrow. Behind these are three long robust spines, placed close to the margin, which should in reality be counted as secondary spines, although when seen from above they have the appearance of being the marginal mouth-spines, and quite mask the small spines just mentioned. The innermost are the longest and reach to the centre of the actinostome, the pair being directed horizontally over the buccal membrane, parallel to one another. The other two spines are smaller and the outermost is the least, and they radiate outward from the foremost slightly and in increasing degree. The shafts of these large secondary mouth-spines are cylindrical, robust, tapering, coarsely striated, covered with delicate membrane crowded with pedicellariæ, which, though small, are larger than any of those before mentioned. The armature of the first pair of adambulacral plates succeeding the mouth-plates is so placed as to appear to belong to the mouth-plate armature; it consists of two small spines one behind the other placed quite in the furrow, then a larger actinal spine which appears to belong to the series of the large secondary mouth-spines, and still more inward on the plate a much larger and more robust actinal spine, this with its companion on the

adjacent plate having at first sight the appearance of being the only pair of true secondary mouth-spines; this is further enhanced by their being the most robust spines of the series, as well as by their position. This character is, however, deceptive, as will be seen from the foregoing remarks. The first pair of adambulacral plates is further noteworthy on account of being separated by a conspicuous azygos shield-shaped plate, bearing superficially the closest resemblance to the mouth-shield of an Ophiurid. This plate extends to the interbrachial arc and is facetted laterally by the rudimentary marginal plate, and in the lateral wall of the disk the cone-shaped plate, the so-called odontophore of Viguier, or wedge-plate of Sars, is seen to stand upon it.

The madreporiform body is very small but prominent; it stands near the margin but far above the cone-shaped plate just mentioned, and its surface is marked by two or three deep, coarse, highly convoluted striations.

A very distinct anal aperture is present in an excentric position.

Colour when dried, an ashy grey, with distinct traces of a violet shade, which are suggestive of that having been the original colour of the specimen.

Locality.—Station 3. South-west of the Canary Islands. February 18, 1873. Lat. 25° 45′ 0″ N., long. 20° 14′ 0″ W. Depth 1525 fathoms. Hard ground. Bottom temperature 37°·0 Fahr.; surface temperature 65°·0 Fahr.

Remarks.—This species is readily distinguished from all the other plated forms of Brisingidæ by the numerous spinelets of the dermal integument of the disk, also by the character of these; by the character and disposition of the adambulacral armature; and by the presence of the remarkable actinally superficial azygos interradial plate. This congeries of characters is sufficient, in my opinion, to clearly mark the generic independence of the form, although the material at my disposal is unfortunately so fragmentary.

CHOROLOGY OF THE SPECIES.

A.—LIST OF STATIONS AND THE GEOGRAPHICAL POSITIONS AT WHICH ASTEROIDEA WERE COLLECTED, WITH THE ENUMERATION OF THE SPECIES OBTAINED AT EACH STATION.

I. Challenger Expedition.

Station I. South-west of Cape Finisterre. December 30, 1872. Lat. 41° 58′ 0″ N., long. 9° 42′ 0″ W. Depth 1125 fathoms. Blue mud.

Hymenaster membranaceus.

Off the coast of Portugal. January 1873. Station and conditions not recorded.

Pararchaster armatus. Also at Stations 46 and 50.

Station V. South of Cape St. Vincent. January 28, 1873. Lat. 35° 47′ 0″ N., long. 8° 23′ 0″ W. Depth 1090 fathoms. Globigerina ooze. Bottom temperature 38°·5 Fahr.; surface temperature 61°·0 Fahr.

Plutonaster bifrons. Also at Station 47.

Station 3. South-west of the Canary Islands. February 18, 1873. Lat. 25° 45′ 0″ N., long. 20° 14′ 0″ W. Depth 1525 fathoms. Hard ground. Bottom temperature 37°·0 Fahr.; surface temperature 65°·0 Fahr.

Nymphaster protentus.
Colpaster scutigerula.

Station 24. North-west of St. Thomas, Virgin Islands. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. Depth 390 fathoms. Pteropod ooze. Surface temperature 76°·0 Fahr.

Brisinga cricophora.

Station 36. Off Bermuda. April 22, 1873. Lat. 32° 7′ 25″ N., long. 65° 4′ 0″ W. Depth 30 fathoms. Coral. Surface temperature 67°·5 Fahr.

Chætaster longipes. Also at Station 75.

Off Bermuda. Depth and conditions not recorded.

Asterina folium.
Asterias (Stolasterias) tenuispina.

Station 44. Off the coast of North America, east of Delaware and Maryland. May 2, 1873. Lat. 37° 25′ 0″ N., long. 71° 40′ 0″ W. Depth 1700 fathoms. Blue mud. Bottom temperature 36°·2 Fahr.; surface temperature 56°·5 Fahr.

Pararchaster semisquamatus, var. *occidentalis.* Or at Station 45.
Pontaster forcipatus. Also at Stations 45, 46, and 50.
Dytaster exilis, var. *carinata.*
Dytaster madreporifer. Also at Station 45.
Plutonaster rigidus. Or at Station 45.
Phoxaster pumilus. Or at Station 45, also at Station 46.

Station 45. Off the coast of North America, east of Delaware and Maryland. May 3, 1873. Lat. 38° 34′ 0″ N., long. 72° 10′ 0″ W. Depth 1240 fathoms. Blue mud. Bottom temperature 37°·2 Fahr.; surface temperature 49°·5 Fahr.

Pararchaster semisquamatus, var. *occidentalis.* Or at Station 44.
Pontaster forcipatus. Also at Stations 44, 46, and 50.
Dytaster madreporifer. Also at Station 44.
Plutonaster rigidus. Or at Station 44.
Porcellanaster cæruleus. Also at Stations 46 and 47.
Phoxaster pumilus. Or at Station 44, also at Station 46.

Station 46. Off the coast of North America, east of New Jersey. May 6, 1873. Lat. 40° 17′ 0″ N., long. 66° 48′ 0″ W. Depth 1350 fathoms. Blue mud. Bottom temperature 37°·2 Fahr.; surface temperature 40°·0 Fahr.

Pararchaster armatus. Also at Station 50, and off Portugal.
Pontaster forcipatus. Also at Stations 44, 45, and 50.
Plutonaster rigidus, var. *semiarmata.* Or at Station 47.
Porcellanaster cæruleus. Also at Stations 45 and 47.
Leptoptychaster arcticus, var. *elongata.* Also at Station 49.
Phoxaster pumilus. Also at Station 44 or 45.
Zoroaster fulgens. Also at Stations 50 and 120.
Cribrella oculata. Also at Stations 48 and 49.
Brisinga verticillata.
Freyella bracteata. Also at Stations 47 and 50.

STATION 47. Off the coast of North America, east of Massachusetts. May 7, 1873. Lat. 41° 14′ 0″ N., long. 65° 45′ 0″ W. Depth 1340 fathoms. Blue mud. Surface temperature 42°·0 Fahr.

Plutonaster bifrons. Also at Station V. or off the coast of Portugal.
Plutonaster rigidus, var. *semiarmata.* Or at Station 46.
Porcellanaster cæruleus. Also at Stations 45 and 46.
Freyella bracteata. Also at Stations 46 and 50.

STATION 48. South-west of Halifax, Nova Scotia. May 8, 1873. Lat. 43° 4′ 0″ N., long. 64° 5′ 0″ W. Depth 51 fathoms. Rock. Surface temperature 38°·0 Fahr.

Crossaster papposus.
Solaster endeca.
Cribrella oculata. Also at Stations 46 and 49.

STATION 49. South of Halifax, Nova Scotia. May 20, 1873. Lat. 43° 3′ 0″ N., long. 63° 39′ 0″ W. Depth 85 fathoms. Gravel, stones. Bottom temperature 35°·0 Fahr.; surface temperature 40°·5 Fahr.

Pontaster hebitus.
Pseudarchaster intermedius.
Leptoptychaster arcticus, var. *elongata.* Also at Station 46.
Pentagonaster granularis.
Hippasteria plana.
Stichaster albulus.
Pteraster militaris.
Cribrella oculata. Also at Stations 46 and 48.
Asterias (*Leptasterias*) *compta.*

STATION 50. South of Halifax, Nova Scotia. May 21, 1873. Lat. 42° 8′ 0″ N., long. 63° 39′ 0″ W. Depth 1250 fathoms. Blue mud. Bottom temperature 38°·0 Fahr.; surface temperature 45°·0 Fahr.

Pararchaster armatus. Also at Station 46, and off Portugal.
Pontaster forcipatus. Also at Stations 44, 45, and 46.
Zoroaster fulgens. Also at Stations 46 and 120.
Asterias (*Hydrasterias*) *ophidion.*
Freyella bracteata. Also at Stations 46 and 47.

STATION 73. West of Fayal, Azores. June 30, 1873. Lat. 38° 30′ 0″ N., long. 31° 14′ 0″ W. Depth 1000 fathoms. Pteropod ooze. Bottom temperature 39°·4 Fahr.; surface temperature 69°·0 Fahr.

Plutonaster notatus.
Neomorphaster eustichus. Also at Station 76.

STATION 75. Between the Islands of Fayal and San Jorge (Azores). July 2, 1873. Lat. 38° 38′ 0″ N., long. 28° 28′ 30″ W. Depth 450 fathoms. Volcanic mud. Surface temperature 70°·0 Fahr.

Astropecten hermatophilus.
Chætaster longipes. Also at Station 36.
Ophidiaster attenuatus.
Ophidiaster ophidianus.

STATION 76. Between the Islands of San Miguel and Pico (Azores). July 3, 1873. Lat. 38° 11′ 0″ N., long. 27° 9′ 0″ W. Depth 900 fathoms. Pteropod ooze. Bottom temperature 40°·0 Fahr.; surface temperature 70°·0 Fahr.

Pontaster venustus. Also at Station 79.
Neomorphaster eustichus. Also at Station 73.

STATION 78. Between the Islands of San Miguel and Santa Maria (Azores). July 10, 1873. Lat. 37° 26′ 0″ N., long. 25° 13′ 0″ W. Depth 1000 fathoms. Volcanic mud. Surface temperature 71°·0 Fahr.

Plutonaster abbreviatus.
Aphroditaster gracilis.
Pentagonaster lepidus.

STATION 79. Between the Azores and Madeira. July 11, 1873. Lat. 36° 21′ 0″ N., long. 23° 31′ 0″ W. Depth 2025 fathoms. Globigerina ooze. Bottom temperature 35°·9 Fahr.; surface temperature 71°·5 Fahr.

Pontaster venustus. Also at Station 76.
Dytaster biserialis.

STATION 89. Between the Canary Islands and Cape Verde Islands. July 23, 1873. Lat. 22° 18′ 0″ N., long. 22° 2′ 0″ W. Depth 2400 fathoms. Globigerina ooze. Bottom temperature 36°·6 Fahr.; surface temperature 73°·5 Fahr.

Lonchotaster tartareus.
Thoracaster cylindratus.
Freyella tuberculata. Also at Station 346.

Off the Cape Verde Islands. Position, depth, and conditions not recorded.

Pontaster venustus, var. *robusta*.
Psilaster cassiope.
Psilaster patagiatus.
Nymphaster albidus.

Off St. Vincent, Cape Verde Islands. Depth and conditions not recorded.

Pentagonaster semilunatus.
Narcissia canariensis.
Asterias (*Stolasterias*) *glacialis*.

Off Porto Praya, St. Jago (Cape Verde Islands).

Pentaceros dorsatus.
Linckia guildingii.

Station 106. Near the Equator, due south of the Cape Verde Islands. August 25, 1873. Lat. 1° 47′ 0″ N., long. 24° 26′ 0″ W. Depth 1850 fathoms. Globigerina ooze. Bottom temperature 36°·6 Fahr.; surface temperature 78°·8 Fahr.

Paragonaster cylindratus.

Off Fernando Noronha. Shallow water.

Astropecten brasiliensis. Also off Bahia.

Station 120. Off Pernambuco. September 9, 1873. Lat. 8° 37′ 0″ S., long. 34° 28′ 0″ W. Depth 675 fathoms. Red mud. Surface temperature 78°·0 Fahr.

Zoroaster fulgens. Also at Stations 46 and 50.

Station 122–122c. Off the coast of Brazil, south-east of Pernambuco. September 10, 1873. Lat. 9° 5′ 0″ S. to 9° 10′ 0″ S., long. 34° 49′ 0″ W. to 34° 53′ 0″ W. Depths 32, 120, 350, 400 fathoms. Red mud. Surface temperature 77°·5 Fahr.

Astropecten cingulatus.
Calyptraster coa.

Station 125. Off the eastern coast of Brazil, near the mouth of the Rio San Francisco. September 12, 1873. Lat. 10° 46′ 0″ S., long. 36° 2′ 0″ W. Depth 1200 fathoms. Red mud. Surface temperature 77°·0 Fahr.

Nymphaster basilicus.

Off Bahia. Depth 7 to 20 fathoms.

Astropecten brasiliensis. Also off Fernando Noronha.
Luidia alternata.
Luidia clathrata.
Narcissia trigonaria. Depth and conditions not recorded.
Echinaster spinosus.

Station 133. In the South Atlantic, west of the Island of Tristan da Cunha. October 11, 1873. Lat. 35° 41′ 0″ S., long. 20° 55′ 0″ W. Depth 1900 fathoms. Globigerina ooze. Bottom temperature 35°·4 Fahr.; surface temperature 58°·0 Fahr.

Dytaster exilis, var. *gracilis.*

Off Inaccessible Island, Tristan da Cunha. Depth 90 fathoms.

Astropecten mesactus.
Cribrella simplex. Also off Marion Island, and at Stations 135c, 145a, and 148.

Station 135c. Off Nightingale Island, Tristan da Cunha. October 17, 1873. Lat. 37° 25′ 30″ S., long. 12° 28′ 30″ W. Depth 110 fathoms. Surface temperature 54°·0 Fahr.

Crossaster penicillatus. Also (?) at Station 145.
Cribrella simplex. Depth 100 to 150 fathoms. Also off Inaccessible Island, off Marion Island, and at Stations 145a and 148.
Asterias (*Stolasterias*) *eustyla.* Depth 100 to 150 fathoms.

Station 137. In the South Atlantic, midway between the Island of Tristan da Cunha and the Cape of Good Hope. October 23, 1873. Lat. 35° 59′ 0″ S., long. 1° 34′ 0″ E. Depth 2550 fathoms. Red clay. Bottom temperature 34°·5 Fahr.; surface temperature 56°·1 Fahr.

Porcellanaster eremicus.

Simon's Bay, Cape of Good Hope.

Pseudarchaster tessellatus.
Astropecten pontoporæus. Shallow water to 20 fathoms.
Psilaster acuminatus. Also at Stations 164 and 167.
Luidia africana.
Calliaster baccatus. Depth 5 to 18 fathoms.

Patiria bellula. Shallow water.
Asterina exigua. Shallow water. Also off Samboangan, Philippine Islands; Sea Point, near Cape Town; and Port Jackson, Australia.
Stichaster felipes. Also at Station 142.
Cribrella ornata. Shallow water to 20 fathoms.
Asterias (*Stolasterias*) *africana.* Shallow water to 20 fathoms.

Sea Point, near Cape Town.

Asterina exigua. Also off Samboangan, Philippine Islands; Simon's Bay, Cape of Good Hope; and Port Jackson, Australia.

STATION 142. South of the Cape of Good Hope. December 18, 1873. Lat. 35° 4′ 0″ S., long. 18° 37′ 0″ E. Depth 150 fathoms. Green sand. Bottom temperature 47°·0 Fahr.; surface temperature 65°·5 Fahr.

Stichaster felipes. Also at Simon's Bay, Cape of Good Hope.

STATION 143. Off the Agulhas Bank, south of the Cape of Good Hope. December 19, 1873. Lat. 36° 48′ 0″ S., long. 19° 24′ 0″ E. Depth 1900 fathoms. Globigerina ooze. Bottom temperature 35°·6 Fahr.; surface temperature 73°·0 Fahr.

Pararchaster pedicifer. Also at Station 147.

STATION 145. Off Marion Island. December 27, 1873. Lat. 46° 43′ 0″ S., long. 38° 4′ 30″ E. Depth 140 fathoms. Volcanic sand. Surface temperature 41°·0 Fahr.

? *Crossaster penicillatus.* Also at Station 135C.
Pedicellaster hypernotius.

Off Marion Island. Depth 50 fathoms.

Leptoptychaster kerguelenensis. Also at Stations 149A, 149D, 149E.
Gnathaster meridionalis. Also at Stations 149D, 149H, 150, and 151.
Gnathaster elongatus. Also at Stations 149H, 150, and 151.
Porania antarctica. Also off Prince Edward Island, and at Station 147.
Pteraster semireticulatus.
Cribrella simplex. Also off Inaccessible Island, and at Stations 135C, 145A, and 148.

Asterias meridionalis. Also at Stations 149D, 149E, and 149H.
Asterias (Smilasterias) scalprifera. Also at Station 151.

STATION 145A. Off Prince Edward Island. December 27, 1873. Lat. 46° 41′ 0″ S., long. 38° 10′ 0″ E. Depth 310 fathoms. Volcanic sand. Surface temperature 41°·5 Fahr.

Cribrella simplex. Also off Inaccessible Island; off Marion Island; and at Stations 135C and 148.

Off Prince Edward Island. Depth 85 to 150 fathoms.

Porania antarctica. Also off Marion Island; and at Station 147.

STATION 146. Between Marion Island and the Crozet Islands. December 29, 1873. Lat. 46° 46′ 0″ S., long. 45° 31′ 0″ E. Depth 1375 fathoms. Globigerina ooze. Bottom temperature 35°·6 Fahr.; surface temperature 43°·0 Fahr.

Pontaster forcipatus, var. *echinata.*
Hymenaster graniferus.
Hymenaster coccinatus.
Hymenaster præcoquis. Also at Station 147.
Brisinga membranacea. Also at Station 147.
Freyella fragilissima. Also at Station 156.

STATION 147. West of the Crozet Islands. December 30, 1873. Lat. 46° 16′ 0″ S., long. 48° 27′ 0″ E. Depth 1600 fathoms. Diatom ooze. Bottom temperature 34°·2 Fahr.; surface temperature 41°·0 Fahr.

Pararchaster pedicifer. Also at Station 143.
Porania antarctica. Also off Marion Island; and off Prince Edward Island.
Hymenaster præcoquis. Also at Station 146.
Brisinga membranacea. Also at Station 146.

STATION 148. Between Marion Island and Kerguelen Island. January 3, 1874. Lat. 46° 47′ 0″ S., long. 51° 37′ 0″ E. Depth 210 fathoms. Hard ground (gravel, shells). Surface temperature 41°·0 Fahr.

Leptoptychaster antarcticus.
Cribrella præstans.
Cribrella simplex. Also off Inaccessible Island; off Marion Island; and at Stations 135C and 145A.

STATION 149A. Betsy Cove, Kerguelen Island. January 14, 1874. Lat. 49° 8′ 0″ S., long. 70° 9′ 0″ E. Depth 40 fathoms. Volcanic mud.

Leptoptychaster kerguelenensis. Depth 15 to 25 fathoms. Also at Stations 149D and 149E; and off Marion Island.

STATION 149D. Royal Sound, Kerguelen Island. January 20, 1874. Lat. 49° 28′ 0″ S., long. 70° 13′ 0″ E. Depth 28 fathoms. Volcanic mud. Surface temperature 41°·0 Fahr.

Leptoptychaster kerguelenensis. Depth 25 to 28 fathoms. Also at Stations 149A, 149E; and off Marion Island.

Gnathaster meridionalis. Also at Stations 149H, 150, 151; and off Marion Island.

Pteraster affinis.

Cribrella simplex, var. *granulosa.*

Perknaster fuscus. Depth 25 fathoms. Also at Station 151.

Echinaster spinulifer. Also at Station 149H.

Pedicellaster scaber. Depth 20 to 25 fathoms.

Asterias meridionalis. Depth 25 to 28 fathoms. Also at Stations 149E and 149H; and off Marion Island.

Asterias perrieri. Depth 25 to 28 fathoms.

STATION 149E. Off Cape Maclear, on the south-east coast of Kerguelen Island. January 21, 1874. Lat. 49° 37′ 0″ S., long. 70° 16′ 0″ E. Depth 30 fathoms. Volcanic mud.

Leptoptychaster kerguelenensis. Also at Stations 149A, 149D; and off Marion Island.

Porania glaber. Also at Station 149H.

Asterias meridionalis. Also at Stations 149D and 149H; and off Marion Island.

STATION 149H. Off Cumberland Bay, Kerguelen Island. January 29, 1874. Lat. 48° 45′ 0″ S., long. 69° 14′ 0″ E. Depth 127 fathoms. Volcanic mud. Surface temperature 39°·8 Fahr.

Bathybiaster loripes, var. *obesa.* Also at Station 151.

Gnathaster meridionalis. Also at Stations 149D, 150, 151; and off Marion Island.

Gnathaster elongatus. Also at Stations 150, 151; and off Marion Island.

Porania glaber. Also at Station 149E.
Retaster peregrinator.
Perknaster densus.
Echinaster spinulifer. Also at Station 149D.
Asterias meridionalis. Also at Stations 149D, 149E, and off Marion Island.
Labidiaster annulatus. Also at Stations 150, 151, and 191.

Off Kerguelen Island. Position not recorded.

Leptoptychaster kerguelenensis. Depth 10 to 50 and 100 fathoms. Also at Stations 149A, 149D, 149E, and off Marion Island.
Cribrella simplex, var. *granulosa.* Depth 10 to 50 fathoms. Also at Station 149D.
Asterias meridionalis. Depth 10 to 50 fathoms. Also at Stations 149D, 149E, 149H, and off Marion Island.
Asterias perrieri. Depth 110 fathoms. Also at Station 149D.

STATION 150. Between Kerguelen Island and Heard Island. February 2, 1874. Lat. 52° 4′ 0″ S., long. 71° 22′ 0″ E. Depth 150 fathoms. Coarse gravel. Bottom temperature 35°·2 Fahr.; surface temperature 37°·5 Fahr.

Gnathaster meridionalis. Also at Stations 149D, 149H, 151, and off Marion Island.
Gnathaster elongatus. Also at Stations 149H, 151, and off Marion Island.
Porania spiculata. Also at Stations 151 and 191.
Solaster subarcuatus.
Pteraster rugatus.
Asterias (*Smilasterias*) *triremis.*
Labidiaster annulatus. Also at Stations 149H, 151 and 191.

STATION 151. Off Heard Island. February 7, 1874. Lat. 52° 59′ 30″ S., long. 73° 33′ 30″ E. Depth 75 fathoms. Volcanic mud. Surface temperature 36°·2 Fahr.

Bathybiaster loripes, var. *obesa.* Also at Station 149H.
Gnathaster meridionalis. Also at Stations 149D, 149H, 150, and off Marion Island.
Gnathaster elongatus. Also at Stations 149H, 150, and off Marion Island.

Porania spiculata. Also at Stations 150 and 191.
Perknaster fuscus. Also at Station 149D.
Asterias (Smilasterias) scalprifera. Also off Marion Island.
Labidiaster annulatus. Also at Stations 149H, 150, and 191.

STATION 153. In the Southern Ocean, amongst the pack ice, close to the Antarctic Circle. February 14, 1874. Lat. 65° 42′ 0″ S., long. 79° 49′ 0″ E. Depth 1675 fathoms. Blue mud. Surface temperature 29°·5 Fahr. (This was the most southern dredging station during the expedition).

Pararchaster antarcticus.

STATION 156. In the neighbourhood of the pack ice, near the Antarctic Circle. February 26, 1874. Lat. 62° 26′ 0″ S., long. 95° 44′ 0″ E. Depth 1975 fathoms. Diatom ooze. Surface temperature 33°·0 Fahr.

Lonchotaster forcipifer. Also at Station 157.
Chitonaster cataphractus.
Freyella fragilissima. Also at Station 146.

STATION 157. South of Australia. March 3, 1874. Lat. 53° 55′ 0″ S., long. 108° 35′ 0″ E. Depth 1950 fathoms. Diatom ooze. Bottom temperature 32°·1 Fahr.; surface temperature 37°·2 Fahr.

Lonchotaster forcipifer. Also at Station 156.
Hyphalaster planus.
Hymenaster latebrosus.

STATION 158. South of Australia, 1099 miles south-west of Cape Otway. March 7, 1874. Lat. 50° 1′ 0″ S., long. 123° 4′ 0″ E. Depth 1800 fathoms. Globigerina ooze. Bottom temperature 33°·5 Fahr.; surface temperature 45°·0 Fahr.

Hymenaster nobilis.
Hymenaster formosus.
Hymenaster sacculatus.
Hymenaster cælatus.
Hymenaster crucifer.

STATION 160. South of Australia. March 13, 1874. Lat. 42° 42′ 0″ S., long. 134° 10′ 0″ E. Depth 2600 fathoms. Red clay. Bottom temperature 33°·9 Fahr.; surface temperature 55°·0 Fahr.

Brisinga discincta.

STATION 161. Off the entrance to Port Philip. April 1, 1874. Lat. 38° 22′ 30″ S., long. 144° 36′ 30″ E. Depth 33 fathoms. Sand. Surface temperature 63°·5 Fahr.

Astropecten pectinatus. Also at Station 162; and off Port Jackson, Australia.

STATION 162. Off East Moncœur Island, Bass Strait. April 2, 1874. Lat. 39° 10′ 30″ S., long. 146° 37′ 0″ E. Depth 38 to 40 fathoms. Sand and shells. Surface temperature 63°·2 Fahr.

Astropecten pectinatus. Also at Station 161; and off Port Jackson, Australia.

Nectria ocellifera.

Stichaster polyplax.

Asterias (*Stolasterias*) *calamaria.* Also off Port Jackson, Australia.

STATION 164. Off the coast of Australia, east of Sydney. June 12, 1874. Lat. 34° 8′ 0″ S., long. 152° 0′ 0″ E. Depth 950 fathoms. Green mud. Bottom temperature 36°·5 Fahr.; surface temperature 69°·5 Fahr.

Pontaster subtuberculatus.

Plutonaster ambiguus.

Psilaster acuminatus. Also at Station 167; and Simon's Bay, Cape of Good Hope.

Off Port Jackson, Australia. Depth 2 to 15 fathoms.

Astropecten polyacanthus. Depth 4 to 15 fathoms. Also off Admiralty Islands; Hong Kong; Yokohama, Japan; and at Station 233.

Astropecten pectinatus. Depth 6 to 15 fathoms. Also at Stations 161 and 162.

Anthenea acuta. Depth 6 to 15 fathoms.

Asterina exigua. Depth 6 fathoms. Also at Simon's Bay, Cape of Good Hope; Sea Point, near Cape Town; and off Samboangan, Philippine Islands.

Asterina gunnii. Depth 7 fathoms.

Asterias (*Stolasterias*) *calamaria.* Also at Station 162.

Sydney Harbour.

Pentagonaster astrologorum.

STATION 166. Off the west coast of New Zealand. June 23, 1874. Lat. 38° 50′ 0″ S., long. 169° 20′ 0″ E. Depth 275 fathoms. Globigerina ooze. Bottom temperature 50°·8 Fahr; surface temperature 58°·5 Fahr.

Cribrella compacta.

STATION 167. North-west of Port Hardy, New Zealand. June 24, 1874. Lat. 39° 32′ 0″ S., long. 171° 48′ 0″ E. Depth 150 fathoms. Blue mud. Surface temperature 58°·5 Fahr.

Psilaster acuminatus. Also at Station 164; and Simon's Bay, Cape of Good Hope.

STATION 167A. Queen Charlotte Sound, New Zealand. June 27, 1874. Lat. 41° 4′ 0″ S., long. 174° 19′ 0″ E. Depth 10 fathoms. Mud. Surface temperature 51°·5 Fahr.

Asterina regularis.

STATION 170. North of the Kermadec Islands. July 14, 1874. Lat. 29° 55′ 0″ S., long. 178° 14′ 0″ W. Depth 520 fathoms. Volcanic mud. Bottom temperature 43°·0 Fahr.; surface temperature 65°·0 Fahr.

Solaster torulatus.
Cribrella sufflata.

STATION 171. North-east of the Kermadec Islands. July 15, 1874. Lat. 28° 33′ 0″ S., long. 177° 50′ 0″ W. Depth 600 fathoms. Hard ground. Bottom temperature 39°·5 Fahr.; surface temperature 66°·5 Fahr.

Freyella polycnema.

Off Tongatabu, Friendly Islands. Conditions not recorded.

Linckia pacifica, var. *diplax.* Also off Kandavu, Fiji Islands.

Off Kandavu, Fiji Islands. On the reefs. August 1874.

Archaster typicus. Also off Samboangan and off Zebu, Philippine Islands; and at Station 200.
Choriaster granulatus. Also off Samboangan, Philippine Islands.
Gymnasteria carinifera.
Fromia milleporella.
Ophidiaster cylindricus.
Leiaster speciosus.
Linckia miliaris. Also off Zebu, Philippine Islands.

Linckia pacifica, var. *diplax*. Also off Tongatabu.
Acanthaster echinites. Also off Zebu, Philippine Islands.
Mithrodia clavigera.
Asterias (*Stolasterias*) *gemmifera*.

STATION 181. In the Coral Sea, south-east of New Guinea. August 25, 1874. Lat. 13° 50′ 0″ S., long. 151° 49′ 0″ E. Depth 2440 fathoms. Red clay. Bottom temperature 35°·8 Fahr.; surface temperature 80°·0 Fahr.

Freyella remex.

STATION 184. Off Torres Strait, Pacific side. August 29, 1874. Lat. 12° 8′ 0″ S., long. 145° 10′ 0″ E. Depth 1400 fathoms. Globigerina ooze. Bottom temperature 36°·0 Fahr.; surface temperature 77°·5 Fahr.

Freyella dimorpha.

STATION 186. In Torres Strait, off Cape York. September 8, 1874. Lat. 10° 30′ 0″ S., long. 142° 18′ 0″ E. Depth 8 fathoms. Coral mud. Surface temperature 77°·2 Fahr.

Astropecten zebra.
Stellaster incei. Also at Stations 187, 188, and 208.
Nepanthia brevis.
Ophidiaster tuberifer.
Metrodira subulata.

STATION 187. In Torres Strait. September 9, 1874. Lat. 10° 36′ 0″ S., long. 141° 55′ 0″ E. Depth 6 fathoms. Coral mud. Surface temperature 77°·7 Fahr.

Astropecten zebra, var. *rosea*.
Luidia forficifera. Also at Station 188.
Stellaster incei. Also at Stations 186, 188, and 208.
Stellaster princeps.
Anthenea tuberculosa.
Pentaceros turritus. Also off Samboangan and off Zebu, Philippine Islands; and at Stations 188 and 212.
Pentaceros callimorphus.
Ophidiaster helicostichus.
Retaster insignis. Also at Station 189.

Torres Strait. Exact position and conditions not recorded.

Anthenea tuberculosa, juv.

STATION 188. In the Arafura Sea, between Cape York and Frederick Henry Island. September 10, 1874. Lat. 9° 59′ 0″ S., long. 139° 42′ 0″ E. Depth 28 fathoms. Green mud. Surface temperature 78°·5 Fahr.

Astropecten granulatus.
Luidia forficifera. Also at Station 187.
Nymphaster symbolicus. Also at Station 204A.
Stellaster incei. Also at Stations 186, 187, and 208.
Pentaceros turritus. Also off Samboangan and off Zebu, Philippine Islands; and at Stations 187 and 212.
Nepanthia maculata.
Rhipidaster vannipes.

STATION 189. In the Arafura Sea. September 11, 1874. Lat. 9° 36′ 0″ S., long. 137° 50′ 0″ E. Depth 25 fathoms. Green mud. Surface temperature 79°·0 Fahr.

Retaster insignis. Also at Station 187.

STATION 191. In the Arafura Sea, north-west of the Arrou Islands. September 23, 1874. Lat. 5° 41′ 0″ S., long. 134° 4′ 30″ E. Depth 800 fathoms. Green mud. Bottom temperature 39°·5 Fahr.; surface temperature 82°·2 Fahr.

Pontaster mimicus.
Dytaster æquivocus.
Porcellanaster caulifer.
Porania spiculata. Also at Stations 150 and 151.
Cnemidaster wyvillii.
Asterias vesiculosa.
Labidiaster annulatus. Also at Stations 149H, 150, and 151.

STATION 192. In the Banda Sea, between the Ki Islands and Banda Islands. September 26, 1874. Lat. 5° 49′ 15″ S., long. 132° 14′ 15″ E. Depth 140 fathoms. Blue mud. Surface temperature 82°·0 Fahr.

Pontaster teres.
Astropecten acanthifer.
Nymphaster symbolicus, var. *breviradiata.*
Paragonaster ctenipes.
Pholidaster distinctus.

Off Amboina. Depth 15 to 100 fathoms.

Astropecten velitaris. Also at the Admiralty Islands.

Station 198. In the Celebes Sea, between Celebes and Mindanao. October 20, 1874. Lat. 2° 55′ 0″ N., long. 124° 53′ 0″ E. Depth 2150 fathoms. Blue mud. Bottom temperature 38°·9 Fahr.; surface temperature 85°·0 Fahr.

Dytaster inermis.
Freyella echinata. Also at Stations 205 and 216.

Station 200. East of Samboangan, Philippine Islands. October 23, 1874. Lat. 6° 47′ 0″ N., long. 122° 28′ 0″ E. Depth 250 fathoms. Green mud. Surface temperature 85°·5 Fahr.

Archaster typicus. Also off Samboangan, Philippine Islands; Zebu, Philippine Islands, on the reefs; and Kandavu, Fiji Islands, on the reefs.

Off Samboangan, Philippine Islands. Depth 10 fathoms.

Archaster typicus. Also at Station 200; off Zebu, Philippine Islands; and Kandavu, Fiji Islands.
Luidia aspera. Also at Stations 204A and 219.
Pentaceros turritus. Also off Zebu, Philippine Islands; and at Stations 187, 188, and 212.
Pentaceros productus, var. *tuberata.* Also at Station 212.
Asterodiscus elegans.
Choriaster granulatus. Also off Kandavu, Fiji Islands.
Asterina exigua. Also at Simon's Bay, Cape of Good Hope; Sea Point, near Cape Town; and Port Jackson, Australia.
Asterina cepheus. On the reefs.
Nardoa tuberculata. Also off Zebu, Philippine Islands.

Station 203. East of Panay Island, Philippine group. October 31, 1874. Lat. 11° 6′ 0″ N., long. 123° 9′ 0″ E. Depth 20 fathoms. Mud. Surface temperature 85°·0 Fahr.

Craspidaster hesperus. Also off Hong Kong.
Astropecten monacanthus.
Luidia longispina.

STATION 204A. Off Tablas Island, Philippine group. November 2, 1874. Lat. 12° 43′ 0″ N., long. 122° 9′ 0″ E. Depth 100 fathoms. Green mud. Surface temperature 84°·0 Fahr.

Astropecten imbellis.
Luidia aspera. Also off Samboangan, Philippine Islands; and at Station 219.
Nymphaster symbolicus. Also at Station 188.
Leptogonaster cristatus.
Pholidaster squamatus.

STATION 205. West of the Island of Luzon, Philippine group. November 13, 1874. Lat. 16° 42′ 0″ N., long. 119° 22′ 0″ E. Depth 1050 fathoms. Blue mud. Bottom temperature 37°·0 Fahr.; surface temperature 82°·0 Fahr.

Pontaster trullipes.
Freyella echinata. Also at Stations 198 and 216.

Off Hong Kong. Depth 10 fathoms.

Craspidaster hesperus. Also at Station 203.
Astropecten polyacanthus. Beach. Also off Port Jackson, Australia; Admiralty Islands; Yokohama, Japan; and at Station 233.

STATION 208. Off the east point of Panay Island, Philippine group. January 17, 1875. Lat. 11° 37′ 0″ N., long. 123° 31′ 0″ E. Depth 18 fathoms. Blue mud. Surface temperature 81°·0 Fahr.

Stellaster incei. Also at Stations 186, 187, and 188.

Off Zebu, Philippine Islands. On the reefs.

Archaster typicus. Also off Samboangan, Philippine Islands; Kandavu, Fiji Islands; and at Station 200.
Pentaceros turritus. Also off Samboangan, Philippine Islands; and at Stations 187, 188, and 212.
Pentaceropsis obtusatus.
Culcita novæ-guineæ. Also at Station 212.
Linckia miliaris. Also off Kandavu, Fiji Islands.
Nardoa tuberculata. Also off Samboangan, Philippine Islands.
Acanthaster echinites. Also off Kandavu, Fiji Islands.
Asterias (*Stolasterias*) *volsellata.* Near Zebu. Depth 95 fathoms.

Station 212. Off Malanipa Island, Philippine group. January 30, 1875. Lat. 6° 54′ 0″ N., long. 122° 18′ 0″ E. Depth 10 fathoms. Sand. Surface temperature 83°·0 Fahr.

Pentaceros turritus. Also off Samboangan and off Zebu, Philippine Islands; and at Stations 187 and 188.
Pentaceros productus, var. *tuberata.* Also off Samboangan, Philippine Islands.
Culcita novæ-guineæ. Also off Zebu, Philippine Islands.

Station 216. Midway between the Pelew Islands and New Guinea. February 16, 1875. Lat. 2° 46′ 0″ N., long. 133° 58′ 0″ E. Depth 1675 fathoms. Globigerina ooze. Bottom temperature 35°·4 Fahr.; surface temperature 82°·8 Fahr.

Freyella echinata. Also at Stations 198 and 205.

Station 218. Off the north coast of New Guinea, south-west of the Admiralty Islands. March 1, 1875. Lat. 2° 33′ 0″ S., long. 144° 4′ 0″ E. Depth 1070 fathoms. Blue mud. Bottom temperature 36°·4 Fahr.; surface temperature 84°·0 Fahr.

Zoroaster tenuis.
Hymenaster pullatus.
Benthaster penicillatus.

Off Admiralty Islands. Depth 16 to 25 fathoms.

Astropecten polyacanthus. Also off Port Jackson, Australia; Hong Kong; Yokohama, Japan; and at Station 233.
Astropecten velitaris. Also off Amboina.
Echinaster eridanella.

Station 219. Off D'Entrecasteaux Reef, north of the Admiralty Islands. March 10, 1875. Lat. 1° 54′ 0″ S., long. 146° 39′ 40″ E. Depth 150 fathoms. Coral mud. Surface temperature 84°·0 Fahr.

Luidia aspera. Also at Station 204A, and off Samboangan, Philippine Islands.
Nymphaster bipunctus.
Palmipes diaphanus.
Tarsaster stoichodes.

Station 224. In the neighbourhood of the Caroline Islands, 100 miles north of the Admiralty Islands. March 21, 1875. Lat. 7° 45′ 0″ N., long. 144° 20′ 0″ E. Depth 1850 fathoms. Globigerina ooze. Bottom temperature 35°·4 Fahr.; surface temperature 81°·2 Fahr.

Styracaster armatus.

Station 226. West of the Mariana or Ladrone Islands. March 25, 1875. Lat. 14° 44′ 0″ N., long. 142° 13′ 0″ E. Depth 2300 fathoms. Radiolarian ooze. Bottom temperature 35°·5 Fahr.; surface temperature 79°·0 Fahr.

Freyella attenuata.

Off Yokohama, Japan. Depth 5 to 25 fathoms.

Astropecten polyacanthus. Also off Port Jackson, Australia; Hong Kong; Admiralty Islands; and at Station 233.
Astropecten japonicus. Also at Stations 233, 233A, and 233B.
Luidia limbata.
Asterina pectinifera.
Asterias torquata.
Asterias amurensis.

Station 232. South of Yeddo, Japan. May 12, 1875. Lat. 35° 11′ 0″ N., long. 139° 28′ 0″ E. Depth 345 fathoms. Green mud. Bottom temperature 41°·1 Fahr.; surface temperature 64°·2 Fahr.

Pontaster oxyacanthus.
Astropecten brevispinus.
Pentagonaster japonicus.
Pentagonaster arcuatus.
Solaster paxillatus.
Asterias (*Stolasterias*) *stichantha.*

Station 233. Off Kobé, Japan. May 17, 1875. Lat. 34° 39′ 0″ N., long. 135° 14′ 0″ E. Depth 8 to 50 fathoms. Mud. Surface temperature 62°·3 Fahr.

Astropecten polyacanthus. Also off Port Jackson, Australia; Hong Kong; Admiralty Islands; and Yokohama, Japan.
Astropecten japonicus. Depth 8 fathoms. Also at Stations 233A, 233B; and off Yokohama, Japan.
Asterina penicillaris.
Asterias versicolor. Also at Station 233A.

Station 233A. North of Awadji Sima. May 19, 1875. Lat. 34° 38′ 0″ N., long. 135° 1′ 0″ E. Depth 50 fathoms. Sand. Surface temperature 62°·6 Fahr.

Astropecten japonicus. Also at Stations 233, 233B; and off Yokohama, Japan.

Asterias versicolor. Also at Station 233.

Station 233B. In the Bingo Nada. May 26, 1875. Lat. 34° 18′ 0″ N., long. 133° 35′ 0″ E. Depth 15 fathoms. Blue mud. Surface temperature 66°·3 Fahr.

Astropecten japonicus. Also at Stations 233, 233A; and off Yokohama, Japan.

Station 235. Off Japan, south of Omae saki. June 4, 1875. Lat. 34° 7′ 0″ N., long. 138° 0′ 0″ E. Depth 565 fathoms. Green mud. Bottom temperature 38°·1 Fahr.; surface temperature 73°·0 Fahr.

Pararchaster semisquamatus. Also at Station 237.

Hymenaster glaucus.

Station 237. Off the coast of Japan, south of Kawatsu. June 17, 1875. Lat. 34° 37′ 0″ N., long. 140° 32′ 0″ E. Depth 1875 fathoms. Blue mud. Bottom temperature 35°·3 Fahr.; surface temperature 73°·0 Fahr.

Pararchaster semisquamatus. Also at Station 235.

Porcellanaster tuberosus.

Hyphalaster inermis.

Psilaster gracilis.

Brisinga armillata.

Freyella pennata.

Station 244. In the Mid-North Pacific, between Yeddo and San Francisco, near the meridian of 170° E. June 28, 1875. Lat. 35° 22′ 0″ N., long. 169° 53′ 0″ E. Depth 2900 fathoms. Red clay. Bottom temperature 35°·3 Fahr.; surface temperature 70°·5 Fahr.

Hymenaster infernalis.

Benthaster wyville-thomsoni.

Freyella heroina.

Station 246. In the Mid-North Pacific, between Yeddo and San Francisco, near the meridian of 180°. July 2, 1875. Lat. 36° 10′ 0″ N., long. 178° 0′ 0″ E. Depth 2050 fathoms. Globigerina ooze. Bottom temperature 35°·1 Fahr.; surface temperature 73°·0 Fahr.

Dytaster spinosus.

STATION 274. In the Mid-Pacific, due north of the Society Islands and due west of the Marquesas Islands. September 11, 1875. Lat. 7° 25′ 0″ S., long. 152° 15′ 0″ W. Depth 2750 fathoms. Radiolarian ooze. Bottom temperature 35°·1 Fahr.; surface temperature 80°·2 Fahr.

Hyphalaster hyalinus.

STATION 286. In the Mid-South Pacific, near the meridian of 135° W., approximately midway between Sydney and Valparaiso. October 16, 1875. Lat. 33° 29′ 0″ S., long. 133° 22′ 0″ W. Depth 2335 fathoms. Red clay. Bottom temperature 34°·8 Fahr.; surface temperature 63°·0 Fahr.

Porcellanaster crassus.
Marsipaster spinosissimus.
Hymenaster echinulatus.
Hymenaster geometricus.

STATION 289. In the Mid-South Pacific, near the meridian of 130° W. October 23, 1875. Lat. 39° 41′ 0″ S., long. 131° 23′ 0″ W. Depth 2550 fathoms. Red clay. Bottom temperature 34°·8 Fahr.; surface temperature 54°·5 Fahr.

Freyella benthophila.

STATION 295. Off the western coast of South America. November 5, 1875. Lat. 38° 7′ 0″ S., long. 94° 4′ 0″ W. Depth 1500 fathoms. Globigerina ooze. Bottom temperature 35°·3 Fahr.; surface temperature 58°·5 Fahr.

Hymenaster carnosus.

STATION 298. Off the western coast of South America, between Valparaiso and the Island of Juan Fernandez. November 17, 1875. Lat. 34° 7′ 0″ S., long. 73° 56′ 0″ W. Depth 2225 fathoms. Blue mud. Bottom temperature 35°·6 Fahr.; surface temperature 59°·0 Fahr.

Porcellanaster gracilis.

Off Valparaiso. November, 1875. Shallow water.

Stichaster aurantiacus. On the shore.
Heliaster helianthus. Shallow water.

Station 299. Off the western coast of South America, between Valparaiso and the Island of Juan Fernandez. December 14, 1875. Lat. 33° 31′ 0″ S., long. 74° 43′ 0″ W. Depth 2160 fathoms. Blue mud. Bottom temperature 35°·2 Fahr.; surface temperature 62°·0 Fahr.

Hyphalaster diadematus.
Marsipaster hirsutus.

Station 300. Off the coast of South America, between the Island of Juan Fernandez and Valparaiso. December 17, 1875. Lat. 33° 42′ 0″ S., long. 78° 18′ 0″ W. Depth 1375 fathoms. Globigerina ooze. Bottom temperature 35°·5 Fahr.; surface temperature 62°·5 Fahr.

Dytaster exilis.
Hymenaster vicarius.
Hymenaster porosissimus.

Station 303. Off the western coast of South America, off the Chonos Archipelago. December 30, 1875. Lat. 45° 31′ 0″ S., long. 78° 9′ 0″ W. Depth 1325 fathoms. Blue mud. Bottom temperature 36°·0 Fahr.; surface temperature 54°·8 Fahr.

Ctenodiscus procurator. Also at Stations 306, 307, 309, and 311.
Mimaster cognatus. Also at Station 311.
Lophaster stellans. Also at Stations 308 and 309.

Station 304. South of Port Otway, Gulf of Peñas. December 31, 1875. Lat. 46° 53′ 15″ S., long. 75° 12′ 0″ W. Depth 45 fathoms. Green sand. Surface temperature 57°·2 Fahr.

Porania magellanica.
Peribolaster folliculatus.
Asterias (*Cosmasterias*) *tomidata.*

Station 306. In the Messier Channel, between Wellington Island and the west coast of Chili. January 2, 1876. Lat. 48° 17′ 0″ S., long. 74° 33′ 0″ W. Depth 565 fathoms. Blue mud. Surface temperature 57°·0 Fahr.

Ctenodiscus procurator. Also at Stations 303, 307, 309, and 311.

Station 306a. In the Messier Channel, between Wellington Island and the west coast of Chili. January 2, 1876. Lat. 48° 27′ 0″ S., long. 74° 30′ 0″ W. Depth 345 fathoms. Blue mud. Bottom temperature 46°·0 Fahr.; surface temperature 57°·5 Fahr.

Asterias (*Cosmasterias*) *sulcifera.*

STATION 307. In the Messier Channel, between the western coast of Chili and Wellington Island. January 4, 1876. Lat. 49° 24′ 30″ S., long. 74° 23′ 30″ W. Depth 140 fathoms. Blue mud. Surface temperature 53°·0 Fahr.

Pseudarchaster discus.
Ctenodiscus procurator. Also at Stations 303, 306, 309, and 311.

In the Messier Channel, between Wellington Island and the west coast of Chili. January, 1876. Exact position, depth, and conditions not recorded.

Calvasterias stolidota. Also at Station 315.

STATION 308. South of Wellington Island, west coast of Patagonia. January 5, 1876. Lat. 50° 8′ 30″ S., long. 74° 41′ 0″ W. Depth 175 fathoms. Blue mud. Surface temperature 51°·7 Fahr.

Solaster regularis.
Lophaster stellans. Also at Stations 303 and 309.

STATION 309. Off Puerto Bueno. January 8, 1876. Lat. 50° 56′ 0″ S., long. 74° 15′ 0″ W. Depth 40 fathoms. Blue mud. Bottom temperature 47°·0 Fahr.; surface temperature 50°·5 Fahr.

Ctenodiscus procurator. Also at Stations 303, 306, 307, and 311.
Lophaster stellans. Also at Stations 303 and 308.

STATION 311. Off the western coast of South America, near the entrance to the Strait of Magellan, opposite Port Churruca. January 11, 1876. Lat. 52° 45′ 30″ S., long. 73° 46′ 0″ W. Depth 245 fathoms. Blue mud. Bottom temperature 46°·0 Fahr.; surface temperature 50°·0 Fahr.

Pontaster planeta.
Ctenodiscus procurator. Also at Stations 303, 306, 307, and 309.
Bathybiaster loripes.
Pentagonaster patagonicus. Also at Station 313.
Mimaster cognatus. Also at Station 303.
Stichaster polygrammus.
Pteraster stellifer.
Retaster gibber.
Cribrella obesa. Also at Station 315.

STATION 313. Near the Atlantic entrance to the Strait of Magellan. January 20, 1876. Lat. 52° 20′ 0″ S., long. 67° 39′ 0″ W. Depth 55 fathoms. Sand. Bottom temperature 47°·8 Fahr.; surface temperature 48°·2 Fahr.

Ctenodiscus australis. Also at Station 320.
Pentagonaster patagonicus. Also at Station 311.
Gnathaster pilulatus.
Cycethra nitida.
Cycethra pinguis.
Ganeria falklandica.
Retaster verrucosus.
Asterias glomerata. Also at Station 315.
Asterias cunninghami. Also at Station 315.
Labidiaster radiosus.

STATION 315. Port William, Falkland Islands. January 26, 1876. Lat. 51° 40′ 0″ S., long. 57° 50′ 0″ W. Depth 12 fathoms. Sand, gravel. Surface temperature 50°·0 Fahr.

Cycethra electilis.
Cribrella obesa. Also at Station 311.
Asterias glomerata. Also at Station 313.
Asterias cunninghami. Also at Station 313.
Calvasterias stolidota. Also in the Messier Channel.

STATION 320. South of Monte Video, off the mouth of the Rio de la Plata. February 14, 1876. Lat. 37° 17′ 0″ S., long. 53° 52′ 0″ W. Depth 600 fathoms. Green sand. Bottom temperature 37°·2 Fahr.; surface temperature 67°·5 Fahr.

Ctenodiscus australis. Also at Station 313.

STATION 323. Off the coast of South America, east of Buenos Ayres. February 28, 1876. Lat. 35° 39′ 0″ S., long. 50° 47′ 0″ W. Depth 1900 fathoms. Blue mud. Bottom temperature 33°·1 Fahr.; surface temperature 73°·5 Fahr.

Pythonaster murrayi.

STATION 325. Off the coast of South America, east of Buenos Ayres. March 2, 1876. Lat. 36° 44′ 0″ S., long. 46° 16′ 0″ W. Depth 2650 fathoms. Blue mud. Bottom temperature 32°·7 Fahr.; surface temperature 70°·8 Fahr.

Pontaster pristinus.
Dytaster nobilis.
Hymenaster pergamentaceus.

Station 335. North of the Island of Tristan da Cunha. March 16, 1876. Lat. 32° 24′ 0″ S., long. 13° 5′ 0″ W. Depth 1425 fathoms. Pteropod ooze. Bottom temperature 37°·0 Fahr.; surface temperature 73°·5 Fahr.

Hymenaster anomalus.

Station 343. Off the Island of Ascension. March 27, 1876. Lat. 8° 3′ 0″ S., long. 14° 27′ 0″ W. Depth 425 fathoms. Volcanic sand. Bottom temperature 40°·3 Fahr.; surface temperature 80°·8 Fahr.

Pararchaster spinosissimus.
Plutonaster marginatus.

Station 346. Between the Guinea coast of Africa and the Island of Ascension. April 6, 1876. Lat. 2° 42′ 0″ S., long 14° 41′ 0″ W. Depth 2350 fathoms. Globigerina ooze. Bottom temperature 34°·0 Fahr.; surface temperature 82°·7 Fahr.

Styracaster horridus.
Freyella tuberculata. Also at Station 89.

II. "Porcupine" Expeditions.

i. 1869 *Cruise.*

Station 8 (1869). Off the west coast of Ireland. Lat. 53° 15′ N., long. 11° 51′ W. Depth 106 fathoms. Bottom temperature 10°·7 C.; surface temperature 12°·3 C.

Porania pulvillus.

Station 18 (1869). Off the west coast of Ireland, north-west of Achill Head. Lat. 54° 15′ N., long. 11° 9′ W. Depth 183 fathoms. Bottom temperature 9°·7 C.; surface temperature 11°·8 C.

Astropecten irregularis. Also at Stations 46, 67, and 68.

Station 19 (1869). West of Donegal Bay. Lat. 54° 53′ N., long. 10° 56′ W. Depth 1360 fathoms. Bottom temperature 3°·0 C.; surface temperature 12°·6 C.

Plutonaster bifrons. Also at Stations 57 and 58.

Station 23 (1869). South of Rockall Bank. Lat. 56° 7′ N., long. 14° 19′ W. Depth 630 fathoms. Bottom temperature 6°·4 C.; surface temperature 14°·0 C.

Brisinga coronata. Also at Station 45; and in 1870 at Station 13.

Station 31 (1869). Between the north of Ireland and Rockall. Lat. 56° 15′ N., long. 11° 25′ W. Depth 1360 fathoms. Bottom temperature 2°·9 C.; surface temperature 13°·8 C.

Plutonaster (*Tethyaster*) *parelii.*
Marginaster fimbriatus.

Station 45 (1869). South-west of Cape Clear. Lat. 51° 1′ N., long. 11° 21′ W. Depth 458 fathoms. Bottom temperature 8°·9 C.; surface temperature 15°·9 C.

Brisinga endecacnemos. Also at Station 74, and off Valentia; and in 1870 at Stations 4, 6, 14, and 17.
Brisinga coronata. Also at Station 23; and in 1870 at Station 13.

Station 46 (1869). Between Scotland and the Faeröe banks. Lat. 59° 23′ N., long. 7° 4′ W. Depth 374 fathoms. Bottom temperature 7°·7 C.; surface temperature 12°·1 C.

Astropecten irregularis. Also at Stations 18, 67, and 68.
Luidia sarsii. Also at Stations 67 and 68.

Station 47a. (1869). In the Faeröe Channel. Lat. 59° 34′ N., long. 7° 18′ W. Depth 542 fathoms. Bottom temperature 6°·5 C.; surface temperature 12°·2 C.

Lasiaster villosus.

Station 51 (1869). In the Faeröe Channel. Lat. 60° 6′ N., long. 8° 14′ W. Depth 440 fathoms. Bottom temperature 5°·5 C.; surface temperature 10°·9 C.

Pontaster limbatus. Also off Valentia; and in 1870 at Station 2.
Pentagonaster granularis.
Cribrella oculata. Also at Stations 52, 54, 62, 65, 74, and 90.
Odinia pandina.

Station 52 (1869). In the Faeröe Channel. Lat. 60° 25′ N., long. 8° 10′ W. Depth 384 fathoms. Bottom temperature −0°·8 C.; surface temperature 11°·2 C.

Crossaster papposus. Also at Stations 57 and 64.
Lophaster furcifer. Also at Station 55.
Cribrella oculata. Also at Stations 51, 54, 62, 65, 74, and 90.

Station 54 (1869). In the Faeröe Channel. Lat. 59° 56′ N., long. 6° 27′ W. Depth 363 fathoms. Bottom temperature −0°·3 C.; surface temperature 11°·4 C.

Pontaster tenuispinus, var. *platynota.* Also off Valentia.
Cribrella oculata. Also at Stations 51, 52, 62, 65, 74, and 90.

STATION 55 (1869). In the Faeröe Channel. Lat. 60° 4′ N., long. 6° 19′ W. Depth 605 fathoms. Bottom temperature −1°·2 C.; surface temperature 11°·4 C.

Lophaster furcifer. Also at Station 52.

STATION 57 (1869). In the Faeröe Channel. Lat. 60° 14′ N., long. 6° 17′ W. Depth 632 fathoms. Bottom temperature −0°·8 C.; surface temperature 11°·1 C.

Plutonaster bifrons. Also at Stations 19 and 58.
Ctenodiscus corniculatus. Also at Stations 58 and 82.
Crossaster papposus. Also at Stations 52 and 64.
Korethraster hispidus.

STATION 58 (1869). In the Faeröe Channel. Lat. 60° 21′ N., long. 6° 51′ W. Depth 540 fathoms. Bottom temperature −0°·6 C.; surface temperature 10°·6 C.

Plutonaster bifrons. Also at Stations 19 and 57.
Ctenodiscus corniculatus. Also at Stations 57 and 82.

STATION 59 (1869). In the Faeröe Channel. Lat. 60° 21′ N., long. 5° 41′ W. Depth 580 fathoms. Bottom temperature −1°·3 C.; surface temperature 11°·5 C.

Hymenaster pellucidus.

STATION 62 (1869). In the Faeröe Channel. Lat. 61° 59′ N., long. 4° 38′ W. Depth 125 fathoms. Bottom temperature 7°·0 C.; surface temperature 9°·8 C.

Cribrella oculata. Also at Stations 51, 52, 54, 65, 74, and 90.

STATION 64 (1869). Between the Faeröe and Shetland Islands. Lat. 61° 21′ N., long. 3° 44′ W. Depth 640 fathoms. Bottom temperature −1°·1 C.; surface temperature 9°·3 C.

Crossaster papposus. Also at Stations 52 and 57.

STATION 65 (1869). In the Faeröe Channel. Lat. 61° 10′ N., long. 2° 21′ W. Depth 345 fathoms. Bottom temperature −1°·1 C.; surface temperature 11°·1 C.

Pontaster tenuispinus. Also at Stations 76 and 90.
Leptoptychaster arcticus. Also at Station 82; and in 1870 at Station 3.
Cribrella oculata. Also at Stations 51, 52, 54, 62, 74, and 90.

Station 67 (1869). East of the Shetland Islands. Lat. 60° 32′ N., long. 0° 29′ W. Depth 64 fathoms. Bottom temperature 9°·5 C.; surface temperature 11°·0 C.

Astropecten irregularis. Also at Stations 18, 46, and 68.
Luidia sarsii. Also at Stations 46 and 68.
Asterias (*Leptasterias*) *mülleri.* Also at Stations 68 and 82.

Station 68 (1869). East of the Shetland Islands. Lat. 60° 23′ N., long. 0° 33′ E. Depth 75 fathoms. Bottom temperature 6°·7 C.; surface temperature 11°·4 C.

Astropecten irregularis. Also at Stations 18, 46, and 67.
Luidia sarsii. Also at Stations 46 and 67.
Asterias (*Leptasterias*) *mülleri.* Also at Stations 67 and 82.

Station 74 (1869). East of the Shetland Islands. Lat. 60° 39′ N., long. 3° 9′ W. Depth 203 fathoms. Bottom temperature 8°·7 C.; surface temperature 11°·4 C.

Cribrella oculata. Also at Stations 51, 52, 54, 62, 65, and 90.
Brisinga endecacnemos. Also at Station 45, and off Valentia; and in 1870 at Stations 4, 6, 14, and 17.

Station 76 (1869). In the Faeröe Channel. Lat. 60° 36′ N., long. 3° 58′ W. Depth 344 fathoms. Bottom temperature −1°·1 C.; surface temperature 10°·1 C.

Pontaster tenuispinus. Also at Stations 65 and 90.
Psilaster andromeda. Also in 1870 at Station 3.
Bathybiaster vexillifer.

Station 82 (1869). In the Faeröe Channel. Lat. 60° 0′ N., long. 5° 13′ W. Depth 312 fathoms. Bottom temperature 5°·2 C.; surface temperature 11°·2 C.

Ctenodiscus corniculatus. Also at Stations 57 and 58.
Leptoptychaster arcticus. Also at Station 65; and in 1870 at Station 3.
Asterias (*Leptasterias*) *mülleri.* Also at Stations 67 and 68.

Station 87 (1869). North-west of the Hebrides. Lat. 59° 35′ N., long. 9° 11′ W. Depth 767 fathoms. Bottom temperature 5°·2 C.; surface temperature 11°·4 C.

Zoroaster fulgens.

Station 90 (1869). In the Faeröe Channel. Lat. 59° 41′ N., long. 7° 34′ W. Depth 458 fathoms. Bottom temperature 7°·3 C.; surface temperature 11°·7 C.

Pontaster tenuispinus. Also at Stations 65 and 76.
Cribrella oculata. Also at Stations 51, 52, 54, 62, 65, and 74.

The Minch (1869). Exact locality and conditions not recorded.

Palmipes membranaceus.

Off Valentia. Depth 100 to 150 fathoms.

Pontaster tenuispinus, var. *platynota.* Also at Station 54.

Pontaster limbatus. Also at Station 51 ; and in 1870 at Station 2.

Brisinga endecacnemos. Depth and conditions not stated. Also at Stations 45 and 74 ; and in 1870 at Stations 4, 6, 14, and 17.

Localities not recorded. Stated to be not found below the 100 fathom line.

Hippasteria plana.

ii. 1870 *Cruise.*

Station 2 (1870). South-west of the Scilly Islands. Lat. 48° 37′ N., long. 10° 9′ W. Depth 305 fathoms. Bottom temperature 14°·8 C. ; surface temperature 16°·2 C.

Pontaster limbatus. Also in 1869 at Station 51, and off Valentia.

Station 3 (1870). West of Ushant. Lat. 48° 31′ N., long. 10° 3′ W. Depth 690 fathoms.

Leptoptychaster arcticus. Also in 1869 at Stations 65 and 82.

Psilaster andromeda. Also in 1869 at Station 76.

Station 4 (1870). West of Ushant. Lat. 48° 32′ N., long. 9° 59′ W. Depth 717 fathoms. Bottom temperature 7°·5 C. ; surface temperature 16°·3 C.

Brisinga endecacnemos. Also at Stations 6, 14, and 17 ; and in 1869 at Stations 45, 74, and off Valentia.

Station 6 (1870). West of Ushant. Lat. 48° 26′ N., long. 9° 44′ W. Depth 358 fathoms. Bottom temperature 10°·0 C. ; surface temperature 16°·9 C.

Brisinga endecacnemos. Also at Stations 4, 14, and 17 ; and in 1869 at Stations 45, 74, and off Valentia.

Station 13 (1870). Off the west coast of Spain. Lat. 40° 16′ N., long. 9° 37′ W. Depth 220 fathoms. Bottom temperature 11°·0 C. ; surface temperature 18°·1 C.

Brisinga coronata. Also in 1869 at Stations 23 and 45.

Station 14 (1870). Off the west coast of Spain. Lat. 40° 6′ N., long. 9° 44′ W. Depth 469 fathoms. Bottom temperature 10°·8 C.; surface temperature 18°·4 C.

Brisinga endecacnemos. Also at Stations 4, 6, and 17; and in 1869 at Stations 45, 74, and off Valentia.

Station 17 (1870). Off the west coast of Spain. Lat. 39° 42′ N., long. 9° 43′ W. Depth 1095 fathoms. Bottom temperature 4°·3 C.; surface temperature 19°·8 C.

Brisinga endecacnemos. Also at Stations 4, 6, and 14; and in 1869 at Stations 45, 74, and off Valentia.

Station 36 (1870). In the Strait of Gibraltar, off the coast of Morocco. Lat. 35° 35′ N., long. 6° 26′ W. Depth 128 fathoms. Bottom temperature 12°·9 C.; surface temperature 23°·8 C.

Luidia africana.

No record of locality or depth.

Porania pulvillus. Also in 1869 at Station 8.
Chætaster longipes.
Stichaster roseus.

III. "Knight Errant" Expedition.

Station 2. In the Faeröe Channel. July 29, 1880. Lat. 60° 29′ N., long. 8° 19′ W. Depth 375 fathoms. Mud. Bottom temperature 31°·0 Fahr.; surface temperature 53°·0 Fahr.

Crossaster papposus, var. *septentrionalis.*

Station 3. Off the Island of North Rona. August 3 and 4, 1880. Lat. 59° 12′ N., long. 5° 57′ W. Depth 53 fathoms.

Luidia sarsii.
Porania pulvillus.
Crossaster papposus.
Cribrella oculata.
Asterias rubens.
Asterias (*Leptasterias*) *mülleri.*

Station 4. In the Faeröe Channel. August 10, 1880. Lat. 59° 33′ N., long. 7° 14′ W. Depth 555 fathoms. Mud. Bottom temperature 45°·4 Fahr.; surface temperature 57°·0 Fahr.

Mimaster tizardi.

STATION 7. In the Faeröe Channel. August 12, 1880. Lat. 59° 37′ N., long. 7° 19′ W. Depth 530 fathoms.

Psilaster andromeda.

STATION 8. In the Faeröe Channel. August 17, 1880. Lat. 60° 3′ N., long. 5° 51′ W. Depth 540 fathoms. Ooze. Bottom temperature 29°·2 Fahr.; surface temperature 56°·5 Fahr.

Pontaster tenuispinus, var. *platynota.*
Plutonaster bifrons.

IV. "TRITON" EXPEDITION.

STATION 1. In the Faeröe Channel. August 4, 1882. Lat. 59° 51′ 30″ N., long. 6° 21′ 0″ W. Depth 240 fathoms. Bottom temperature 47°·6 Fahr.

Cribrella oculata. Also at Stations 10 and 11.

STATION 2. In the Faeröe Channel. August 5, 1882. Lat. 59° 37′ 30″ N., long. 6° 49′ 0″ W. Depth 530 fathoms. Bottom temperature 46°·2 Fahr.

Pteraster militàris.

STATION 3. In the Faeröe Channel. August 8, 1882. Lat. 60° 39′ 30″ N., long. 9° 6′ 0″ W. Depth 87 fathoms. Bottom temperature 49°·5 Fahr.

Luidia ciliaris.
Hippasteria plana.

STATION 5. In the Faeröe Channel. August 10, 1882. Lat. 60° 11′ 0″ to 60° 20′ 0″ N., long. 8° 15′ 0″ to 8° 8′ 0″ W. Depth 433 to 285 fathoms. Bottom temperature 43°·5 to 40°·8 Fahr.

Rhegaster murrayi.
Asterias (*Leptasterias*) *mülleri.*

STATION 9. In the Faeröe Channel. August 23, 1882. Lat. 60° 5′ 0″ N., long. 6° 21′ 0″ W. Depth 608 fathoms. Bottom temperature 30°·0 Fahr.

Pontaster tenuispinus, var. *platynota.*
Pteraster militaris, var. *prolata.*

STATION 10. In the Faeröe Channel. August 24, 1882. Lat. 59° 40′ 0″ N., long. 7° 21′ 0″ W. Depth 516 fathoms. Bottom temperature 46°·0 Fahr.

Plutonaster bifrons. Also at Station 11.
Psilaster andromeda. Also at Station 11.
Mimaster tizardi. Also at Station 11.
Cribrella oculata, var. (see p. 543). Also at Stations 1 and 11.

STATION 11. In the Faeröe Channel. August 28, 1882. Lat. 59° 29′ 0″ N., long. 7° 13′ 0″ W. Depth 555 fathoms. Bottom temperature 45°·5 Fahr.

Plutonaster bifrons. Also at Station 10.
Psilaster andromeda. Also at Station 10.
Mimaster tizardi. Also at Station 10.
Zoroaster fulgens. Also at Station 13.
Cribrella oculata, var. (see p. 543). Also at Stations 1 and 10.

STATION 13. In the Faeröe Channel. August 31, 1882. Lat. 59° 51′ 2″ N., long. 8° 18′ 0″ W. Depth 570 fathoms. Bottom temperature 45°·7 Fahr.

Zoroaster fulgens. Also at Station 11.

V. "LIGHTNING" EXPEDITION.

STATION 6. In the Faeröe Channel. Lat. 60° 45′ 0″ N., long. 4° 49′ 0″ W. Depth 510 fathoms. Bottom temperature 0°·5 C.

Pontaster tenuispinus.

STATION 7. In the Faeröe Channel. September 3, 1868. Lat. 60° 7′ 0″ N., long. 5° 21′ 0″ W. Depth 500 fathoms. Bottom temperature 1°·1 C.; surface temperature 10°·5 C.

Odinia pandina.

Off Valentia. Depth and conditions not stated.

Porania pulvillus.

Table of the Distribution of the Genera of Asteroidea collected by the Challenger in the great Oceanic Areas, showing the number of Species by which each is known to be represented, and the number of Species which are common to two or more Oceans.

	I. North Atlantic.	II. South Atlantic.	III. Indian Ocean.	IV. Southern Ocean.	V. Eastern Archi-pelago.	VI. North Pacific.	VII. South Pacific.	Species common to two or more Oceanic Areas.[1]
PHANEROZONIA.								
ARCHASTERIDÆ.								
PARARCHASTERINÆ.								
Pararchaster . .	2 or (?) 3	1	...	2	...	1	...	(I.)VI. / 1
Pontaster . . .	6 or (?) 9	1	...	1	2	2	2	I.(IV.) / 1
PLUTONASTERINÆ.								
Dytaster . . .	3 or (?) 4	2	...	...	2	1	1	(I.)(II.)VII. / 1
Plutonaster . .	4 or (?) 5	1	...	...	...	...	1	.....
—Tethyaster . .	2	...	...	...	...	...	...	.....
Lonchotaster . .	1	...	...	1	...	...	...	.....
PSEUDARCHASTERINÆ.								
Pseudarchaster .	1	1	...	...	...	...	1	.....
Aphroditaster . .	1	...	...	...	...	...	...	.....
ARCHASTERINÆ.								
Archaster . . .	...	...	2	...	2	1	2	III.V.VII., / 2 ; III.V.VI.VII. / 1
PORCELLANASTERIDÆ.								
PORCELLANASTERINÆ.								
Porcellanaster . .	3 or (?) 5	1	...	...	1	1	2	.....
Styracaster . .	2	1	...	...	...	1	...	.....
Hyphalaster . .	2	...	...	1	...	1	2	.....
Thoracaster . .	1	...	...	...	...	...	...	.....
CTENODISCINÆ.								
Ctenodiscus . .	1	1	...	...	...	...	1	.....
ASTROPECTINIDÆ.								
ASTROPECTININÆ.								
Craspidaster . .	...	...	...	...	1	1	...	V.VI. / 1
Leptoptychaster .	1	...	...	2	...	...	...	.....
Astropecten . .	18	6	9	...	8	9	8	I.II., / 2 ; III.VI.VII., / 1 ; V.VI.VII., / 1 ; VI.VII. / 4
Psilaster . . .	3	1	...	...	...	1	1	II.VII. / 1
Phoxaster . . .	1	...	...	...	...	...	...	.....
Bathybiaster . .	2	...	...	1	...	...	1	(IV.)VII. / 1

[1] The Oceans are indicated by Roman numerals corresponding to the numbers at the head of their column; and the Oceans in which a common species occurs are placed together in the position of the numerator of a fraction; the number of species common to them is indicated by an Arabic numeral in the position of the denominator. Thus $\frac{III.V.}{1}$ signifies that one species found in the Indian Ocean also occurs in the Eastern Archipelago; $\frac{III.V.VII.}{2}$ would signify that two species occurring in the Indian Ocean are found in the Eastern Archipelago, and also extend into the South Pacific. When a species is represented by a variety, and not the identical form, the numeral indicating the Ocean in which the variety occurs is placed in brackets; thus $\frac{I.(IV.)}{1}$ indicates that a species found in the North Atlantic is represented by a variety of that species in the Southern Ocean.

	I. North Atlantic.	II. South Atlantic.	III. Indian Ocean.	IV. Southern Ocean.	V. Eastern Archi-pelago.	VI. North Pacific.	VII. South Pacific.	Species common to two or more Oceanic Areas.
PHANEROZONIA.								
Astropectinidæ.								
Luidiinæ.								
Luidia	10	4	4	...	5	8	2	I.II., III.V., III.V.VI., V.VII., VI.VII. (4, 2, 1, 1, 1)
Pentagonasteridæ.								
Pentagonasterinæ.								
Pentagonaster . .	17 or (?) 19	2	6	...	3 or (?) 4	3	13	II.VII., I.II.III.V.VI., III.VII., V.VII. (1, 1, 3, 1 or (?) 2)
Calliaster . . .	...	1	...	...	...	1	...	.....
Chitonaster . . .	...	...	...	1	...	...	...	.....
Gnathaster . . .	...	3	...	2	1	...	3 or (?) 4	II.V. (1)
Nymphaster . .	2 or (?) 6	1	(?) 1	...	1	...	1	.....
Paragonaster . .	1	...	...	...	1	...	...	.....
Nectria	...	...	...	1 or (?) 2	...	...	1	IV.VII. (1)
Goniodiscinæ.								
Stellaster . . .	...	...	1 or (?) 2	...	2 or (?) 4	3	1 or (?) 3	V.VI.VII., V.VII. (2, 1)
Leptogonaster . .	...	...	...	...	1	...	...	.....
Mimasterinæ.								
Mimaster . . .	1	...	...	...	...	...	1	.....
Antheneidæ.								
Anthenea . . .	...	...	4	...	1 or (?) 2	2	3 or (?) 4	III.VI., III.VII., V.VII. (2, 2, 2)
Hippasteria . .	1	...	...	...	...	...	...	.....
Pentacerotidæ.								
Pentaceros . . .	3 or (?) 4	1	18 or (?) 19	...	11	3	9 or (?) 10	III.V., III.V.VII., III.VII., I.II.III., VI.VII. (4, 2, 3, 1, 2)
Pentaceropsis . .	...	...	(?) 1	...	1	...	...	[?III.]V. (1)
Culcita	...	...	4	1	4	1	3 or (?) 4	III.V., III.V.VII. (3, 1 or (?) 2)
Asterodiscus . .	...	...	...	...	1	1	...	V.VI. (1)
Choriaster . . .	...	...	...	...	1	1	1	V.VI.VII. (1)
Gymnasteriidæ.								
Gymnasteria . .	...	...	1	...	1 or (?) 2	1	1 or (?) 2	III.V.VI.VII. (1)
Porania	2	1	...	3	1	...	1	II.IV., IV.V. (1, 1)
Marginaster . .	4	...	...	...	...	...	...	.....
Rhegaster . . .	2	...	...	...	...	...	...	.....
Lasiaster . . .	2	...	...	...	...	...	...	.....
Asterinidæ.								
Ganeriinæ.								
Cycethra . . .	...	4	...	...	...	...	1	II.VII. (1)
Ganeria	...	1	...	...	...	...	...	.....

	I. North Atlantic.	II. South Atlantic.	III. Indian Ocean.	IV. Southern Ocean.	V. Eastern Archi-pelago.	VI. North Pacific.	VII. South Pacific.	Species common to two or more Oceanic Areas.
PHANEROZONIA.								
Asterinidæ.								
Asterininæ.								
Patiria	...	1	2	...	...	...	...	.....
Nepanthia . . .	...	...	1	...	2	...	1	.....
Asterina . . .	8	6	7 or 8	1	4 or 5	6	12	I.II., I.III.V., (?) 1; II.III., II.VII., 3, 2; II.III.IV.V.VII., 1; III.V., III.V.VII., 4 or (?) 5, 3; III.V.VI.VII., III.VII., 1, 1
Palmipedinæ.								
Palmipes . . .	1	...	1	...	...	1	1	III.VI., 1
CRYPTOZONIA.								
Linckiidæ.								
Chætasterinæ.								
Chætaster . . .	2	...	...	...	...	...	...	.....
Linckiinæ.								
Fromia	...	...	3	...	2	2	2	III.V.VI.VII., 1
Ophidiaster . .	5	...	8	...	6	2	6	III.V., III.V.VII., 3, 1; V.VII., 2
Leiaster	...	...	3	...	1	1	1	V.VII., 1
Linckia	3	1	6	...	5	3 or (?) 4	4	I.II., III.VII., 1, 3; III.V.VII., 3; III.(VI.)VII., (?) 1; III.V.VI.VII., 2
Nardoa	...	...	4	...	6	3	4	I.V., III.V., III.VII., 1, 1, 2; V.(VI.), V.VII., 1, 2; III.V.VII., III.VI.VII., 1, 1
Narcissia . . .	1	1	...	...	...	...	...	.....
Metrodirinæ.								
Metrodira . . .	...	...	...	...	1	1	1	V.VII., 1
Zoroasteridæ.								
Zoroaster . . .	5	1	...	...	...	...	1	I.II., 1
Cnemidaster . .	...	...	...	...	1	...	...	.....
Pholidaster . . .	...	...	...	...	2	...	...	.....
Stichasteridæ.								
Stichaster . . .	4	2	...	...	...	...	4	.....
Neomorphaster .	1	...	...	...	...	...	...	.....
Tarsaster . . .	...	...	...	...	...	...	1	.....

	I. North Atlantic.	II. South Atlantic.	III. Indian Ocean.	IV. Southern Ocean.	V. Eastern Archi-pelago.	VI. North Pacific.	VII. South Pacific.	Species common to two or more Oceanic Areas.
CRYPTOZONIA.								
Solasteridæ.								
Solasterinæ.								
Crossaster . . .	2	...	...	1	...	1	1	.....
Rhipidaster . .	...	...	...	...	1	...	...	.....
Solaster	4	...	...	1	...	2	2	I.(VI.) 1
Lophaster . . .	1	...	...	...	...	...	1	.....
Korethrasterinæ.								
Korethraster . .	1 or (?) 4	...	...	...	...	...	...	.....
Peribolaster . .	...	...	...	...	...	...	1	.....
Pterasteridæ.								
Pterasterinæ.								
Pteraster . . .	4	1	...	3	...	1	1	.....
Retaster	1	2	1	1	2	...	2	III.V., V.VII. 1 1
Marsipaster . .	1	...	...	...	...	...	2	.....
Calyptraster . .	...	1	...	...	...	...	...	.....
Hymenaster . .	5	2	...	9	...	2	6	.....
Benthaster . . .	...	...	...	...	...	1	1	.....
Pythonasterinæ.								
Pythonaster . .	...	1	...	...	...	...	...	.....
Echinasteridæ.								
Acanthasterinæ.								
Acanthaster . .	...	...	2	...	1	2	3	VI.VII., III.V.VI.VII. 2 1
Mithrodiinæ.								
Mithrodia . . .	...	1	1	...	1	2	1	III.V.VI.VII. 1
Echinasterinæ.								
Cribrella . . .	3	5	...	2	...	2	5	I.II., II.IV., II.VII. 1 1 2
Perknaster . . .	...	...	...	2	...	...	...	.....
Echinaster . . .	7	2	3	1	1	1	3	I.II., III.V.VII. 1 1
Heliasteridæ.								
Heliaster . . .	...	...	...	...	...	2	4	VI.VII. 1
Pedicellasteridæ.								
Pedicellaster . .	5	2	...	2	...	...	...	.....
Asteriidæ.								
Asterias	28	14	1 or (?) 2	4	2	28	19 or (?) 21	II.VII. 1
— *Cosmasterias* .	...	1	...	...	...	...	2	II.VII. 1
— *Smilasterias* .	...	...	...	2	...	...	...	.....
— *Hydrasterias* .	1	...	...	...	...	...	...	.....
— *Leptasterias* .	2	...	...	...	...	...	...	.....
— *Stolasterias* .	2	3	1	...	1	1	2	I.II., III.VII. 1 1
Calvasterias . .	...	2	...	...	1	...	1	II.V., II.VII. 1 1
Brisingidæ.								
Labidiaster. . .	...	1	...	1	1	...	1	II.VII., IV.V. 1 1
Odinia	4	...	...	...	...	...	...	.....
Brisinga . . .	6	...	...	2	...	1	...	.....
Freyella	7	1	...	1	1	4	4	I.II., V.VI. 1 1
Colpaster . . .	1	...	...	...	...	...	...	.....

B.—BATHYMETRICAL RANGE OF THE SPECIES.

I. CHALLENGER EXPEDITION.

(1.) Littoral Zone.

Species found in depths which extend from the Shore to 150 *fathoms.*

	Depth in Fathoms.	Occurrence in other Zones.
Archasteridæ.		
Pararchasterinæ.		
Pontaster hebitus	85	.....
Pontaster teres	140	.....
Pseudarchasterinæ.		
Pseudarchaster discus	140	.....
Pseudarchaster intermedius	85	.....
Archasterinæ.		
Archaster typicus	10	Also Continental.
Porcellanasteridæ.		
Ctenodiscinæ.		
Ctenodiscus australis	55	Also Abyssal.
Ctenodiscus procurator	140	Also Continental and Abyssal.
Astropectinidæ.		
Astropectininæ.		
Craspidaster hesperus	20	.....
Leptoptychaster kerguelenensis	100	.....
Leptoptychaster arcticus, var. *elongata*	85	Also Abyssal.
Astropecten brasiliensis	20	.....
Astropecten polyacanthus	50	.....
Astropecten pectinatus	40	.....
Astropecten acanthifer	140	.....
Astropecten japonicus	50	.....
Astropecten imbellis	100	.....
Astropecten pontoporæus	20	.....
Astropecten zebra	8	.....
Astropecten zebra, var. *rosea*	6	.....
Astropecten velitaris	100	.....
Astropecten granulatus	28	.....
Astropecten monacanthus	20	.....
Astropecten cingulatus	120	Also Continental.
Astropecten mesactus	90	.....
Psilaster acuminatus	150	Also Abyssal.
Bathybiaster loripes, var. *obesa*	127	.....
Luidiinæ.		
Luidia aspera	150	.....
Luidia alternata	20	.....
Luidia limbata	25	.....
Luidia clathrata	20	.....
Luidia longispina	20	.....
Luidia forficifer	28	.....

	Depth in Fathoms.	Occurrence in other Zones.
Pentagonasteridæ.		
Pentagonasterinæ.		
Pentagonaster granularis	85	.....
Pentagonaster patagonicus	55	Also Continental.
Calliaster baccatus	18	.....
Gnathaster meridionalis	150	.....
Gnathaster elongatus	150	.....
Gnathaster pilulatus	55	.....
Nymphaster symbolicus	115	.....
Nymphaster symbolicus, var. *breviradiata*	140	.....
Nymphaster bipunctus	150	.....
Paragonaster ctenipes	140	.....
Nectria ocellifera	40	.....
Goniodiscinæ.		
Stellaster incei	28	.....
Stellaster princeps	6	.....
Leptogonaster cristatus	115	.....
Antheneidæ.		
Anthenea acuta	15	.....
Anthenea tuberculosa	6	.....
Hippasteria plana	85	.....
Pentacerotidæ.		
Pentaceros turritus	28	.....
Pentaceros productus, var. *tuberata*	10	.....
Pentaceros callimorphus	6	.....
Pentaceropsis obtusatus	...	.....
Culcita novæ-guineæ	10	.....
Asterodiscus elegans	10	.....
Choriaster granulatus	10	.....
Gymnasteriidæ.		
Gymnasteria carinifera	...	.....
Porania antarctica	150	Also Abyssal.
Porania glaber	120	.....
Porania spiculata	150	Also Abyssal.
Porania magellanica	45	.....
Asterinidæ.		
Ganeriinæ.		
Cycethra electilis	12	.....
Cycethra nitida	55	.....
Cycethra pinguis	55	.....
Ganeria falklandica	55	.....
Asterininæ.		
Patiria bellula	...	.....
Nepanthia brevis	8	.....
Nepanthia maculata	28	.....
Asterina regularis	10	.....
Asterina exigua	10	.....
Asterina gunnii	7	.....
Asterina pectinifera	25	.....
Asterina cepheus	10	.....
Asterina penicillaris	50	.....
Palmipedinæ.		
Palmipes diaphanus	150	.....
Linckiidæ.		
Chætasterinæ.		
Chætaster longipes	30	Also Continental.

	Depth in Fathoms.	Occurrence in other Zones.
Linckiidæ.		
Linckiinæ.		
Fromia milleporella	...	.....
Ophidiaster cylindricus	...	.....
Ophidiaster tuberifer	8	.....
Ophidiaster helicostichus	6	.....
Leiaster speciosus	...	.....
Linckia miliaris	...	.....
Linckia pacifica, var. *diplax*	...	.....
Nardoa tuberculata	10	.....
Metrodirinæ.		
Metrodira subulata	8	.....
Zoroasteridæ.		
Pholidaster squamatus	100	.....
Pholidaster distinctus	140	.....
Stichasteridæ.		
Stichaster aurantiacus	...	.....
Stichaster albulus	85	.....
Stichaster polyplax	40	.....
Stichaster felipes	150	.....
Tarsaster stoichodes	150	.....
Solasteridæ.		
Solasterinæ.		
Crossaster papposus	51	.....
Crossaster penicillatus	140	.....
Rhipidaster vannipes	28	.....
Solaster endeca	51	.....
Solaster subarcuatus	150	.....
Lophaster stellans	40	Also Continental and Abyssal.
Korethrasterinæ.		
Peribolaster folliculatus	45	.....
Pterasteridæ.		
Pterasterinæ.		
Pteraster militaris	85	.....
Pteraster affinis	28	.....
Pteraster rugatus	150	.....
Pteraster semireticulatus	50	.....
Retaster verrucosus	55	.....
Retaster peregrinator	127	.....
Retaster insignis	25	.....
Echinasteridæ.		
Acanthasterinæ.		
Acanthaster echinites	...	.....
Mithrodiinæ.		
Mithrodia clavigera	...	.....
Echinasterinæ.		
Cribrella oculata	85	Also Abyssal.
Cribrella ornata	20	.....
Cribrella obesa	12	Also Continental.
Cribrella simplex	150	Also Continental.
Cribrella simplex, var. *granulosa*	50	.....
Perknaster fuscus	75	.....
Perknaster densus	127	.....
Echinaster spinosus	20	.....
Echinaster eridanella	25	.....

	Depth in Fathoms.	Occurrence in other Zones.
Echinasteridæ.		
Echinasterinæ.		
Echinaster spinulifer	127	.....
Heliasteridæ.		
Heliaster helianthus	...	.....
Pedicellasteridæ.		
Pedicellaster scaber	25	.....
Pedicellaster hypernotius	140	.....
Asteriidæ.		
Asterias meridionalis	127	.....
Asterias perrieri	110	.....
Asterias torquata	25	.....
Asterias glomerata	55	.....
Asterias versicolor	50	.....
Asterias amurensis	25	.....
Asterias cunninghami	55	.....
Asterias (Cosmasterias) tomidata	45	.....
Asterias (Smilasterias) scalprifera	75	.....
Asterias (Smilasterias) triremis	150	.....
Asterias (Leptasterias) compta	85	.....
Asterias (Stolasterias) gemmifera	...	.....
Asterias (Stolasterias) tenuispina	...	.....
Asterias (Stolasterias) calamaria	40	.....
Asterias (Stolasterias) volsellata	95	.....
Asterias (Stolasterias) eustyla	150	.....
Asterias (Stolasterias) africana	20	.....
Calvasterias stolidota	10	.....
Brisingidæ.		
Labidiaster radiosus	55	.....
Labidiaster annulatus	150	Also Abyssal.

The above table comprises 141 species and varieties found in the Littoral Zone. Of these 8 extend into the Continental Zone, and 9 extend into the Abyssal Zone.

(2.) Continental Zone.

Species found in depths between 150 *fathoms and* 500 *fathoms.*

	Depth in Fathoms.	Occurrence in other Zones.
Archasteridæ.		
Pararchasterinæ.		
Pararchaster spinosissimus	425	.....
Pontaster planeta	245	.....
Pontaster oxyacanthus	345	.....
Plutonasterinæ.		
Plutonaster marginatus	425	.....
Archasterinæ.		
Archaster typicus	250	Also Littoral.

	Depth in Fathoms.	Occurrence in other Zones.
PORCELLANASTERIDÆ.		
CTENODISCINÆ.		
Ctenodiscus procurator	245	Also Littoral and Abyssal.
ASTROPECTINIDÆ.		
ASTROPECTININÆ.		
Leptoptychaster antarcticus	210	.....
Astropecten brevispinus	345	.....
Astropecten hermatophilus	450	.....
Astropecten cingulatus	400	Also Littoral.
Bathybiaster loripes	245	.....
PENTAGONASTERIDÆ.		
PENTAGONASTERINÆ.		
Pentagonaster patagonicus	245	Also Littoral.
Pentagonaster japonicus	345	.....
Pentagonaster arcuatus	345	.....
MIMASTERINÆ.		
Mimaster cognatus	245	Also Abyssal.
LINCKIIDÆ.		
CHÆTASTERINÆ.		
Chætaster longipes	450	Also Littoral.
LINCKIINÆ.		
Ophidiaster attenuatus	450	.....
Ophidiaster ophidianus	450	.....
STICHASTERIDÆ.		
Stichaster polygrammus	245	.....
SOLASTERIDÆ.		
SOLASTERINÆ.		
Solaster regularis	175	.....
Solaster paxillatus	345	.....
Lophaster stellans	175	Also Littoral and Abyssal.
PTERASTERIDÆ.		
PTERASTERINÆ.		
Pteraster stellifer	245	.....
Retaster gibber	245	.....
Calyptraster coa	350	.....
ECHINASTERIDÆ.		
ECHINASTERINÆ.		
Cribrella compacta	275	.....
Cribrella obesa	245	Also Littoral.
Cribrella præstans	210	.....
Cribrella simplex	310	Also Littoral.
ASTERIIDÆ.		
Asterias (Cosmasterias) sulcifera	345	.....
Asterias (Stolsaterias) stichantha	345	.....
BRISINGIDÆ.		
Brisinga cricophora	390	.....

The above table comprises 32 species found in the Continental Zone. Of these 8 extend into the Littoral Zone, and 3 extend into the Abyssal Zone; and two of the three which pass into the Abyssal Zone are also found in the Littoral Zone.

(3.) Abyssal Zone.

Species found in depths greater than 500 fathoms.

	At or greater than						Greatest Depth recorded.	Occurrence in other Zones.
	500	750	1000	1500	2000	2500		
Archasteridæ.								
Pararchasterinæ.								
Pararchaster semisquamatus	+	...	...	+	...	...	1875	.....
Pararchaster semisquamatus, var. *occidentalis*	...	...	+	+	...	...	1700	.....
Pararchaster antarcticus	...	...	...	+	...	...	1675	.....
Pararchaster pedicifer	...	...	...	+	...	...	1900	.....
Pararchaster armatus	...	...	+	...	...	...	1350	.....
Pontaster forcipatus	...	...	+	+	...	...	1700	.....
Pontaster forcipatus, var. *echinata*	...	...	+	...	...	...	1375	.....
Pontaster mimicus	...	+	...	...	...	...	800	.....
Pontaster pristinus	...	...	...	...	...	+	2650	.....
Pontaster venustus	...	+	...	...	+	...	2025	.....
Pontaster trullipes	...	...	+	...	...	...	1050	.....
Pontaster subtuberculatus	...	+	...	...	...	...	950	.....
Plutonasterinæ.								
Dytaster spinosus	...	...	...	...	+	...	2050	.....
Dytaster exilis	...	...	+	...	...	...	1375	.....
Dytaster exilis, var. *gracilis*	...	...	...	+	...	...	1900	.....
Dytaster exilis, var. *carinata*	...	...	...	+	...	...	1700	.....
Dytaster madreporifer	...	...	+	+	...	...	1700	.....
Dytaster nobilis	...	...	...	...	...	+	2650	.....
Dytaster æquivocus	...	+	...	...	...	...	800	.....
Dytaster biserialis	..	...	...	...	+	...	2025	.....
Dytaster inermis	...	...	...	...	+	...	2150	.....
Plutonaster bifrons	...	...	+	...	...	...	1340	.....
Plutonaster rigidus	...	...	+	+	...	...	1700	.....
Plutonaster rigidus, var. *semiarmata*	...	...	+	...	...	...	1350	.....
Plutonaster ambiguus	...	+	...	...	...	...	950	.....
Plutonaster notatus	...	...	+	...	...	...	1000	.....
Plutonaster abbreviatus	...	...	+	...	...	...	1000	.....
Lonchotaster tartareus	...	...	...	...	+	...	2400	.....
Lonchotaster forcipifer	...	...	...	+	...	...	1975	.....
Pseudarchasterinæ.								
Aphroditaster gracilis	...	...	+	...	...	...	1000	.....
Porcellanasteridæ.								
Porcellanasterinæ.								
Porcellanaster cæruleus	...	...	+	...	...	...	1350	.....
Porcellanaster caulifer	...	+	...	...	...	...	800	.....
Porcellanaster tuberosus	...	...	...	+	...	...	1875	.....
Porcellanaster crassus	...	...	...	...	+	...	2335	.....
Porcellanaster gracilis	...	...	...	...	+	...	2225	.....
Porcellanaster eremicus	...	...	...	...	...	+	2550	.....
Styracaster horridus	...	...	...	...	+	...	2350	.....
Styracaster armatus	...	...	...	+	...	...	1850	.....
Hyphalaster hyalinus	...	...	...	...	...	+	2750	.....
Hyphalaster diadematus	...	...	...	...	+	...	2160	.....
Hyphalaster inermis	...	...	...	+	...	...	1875	.....
Hyphalaster planus	...	...	...	+	...	...	1950	.....
Thoracaster cylindratus	...	...	...	...	+	...	2400	.....

	At or greater than						Greatest Depth recorded.	Occurrence in other Zones.
	500	750	1000	1500	2000	2500		
PORCELLANASTERIDÆ.								
CTENODISCINÆ.								
Ctenodiscus australis	+	...	...	...	...	...	600	Also Littoral.
Ctenodiscus procurator	+	...	+	...	...	...	1325	Also Littoral and Continental.
ASTROPECTINIDÆ.								
ASTROPECTININÆ.								
Leptoptychaster arcticus, var. *elongata*	...	...	+	...	...	...	1350	Also Littoral.
Psilaster acuminatus	...	+	...	...	...	...	950	Also Littoral.
Psilaster gracilis	...	...	...	+	...	...	1875	.....
Phoxaster pumilus	...	...	+	+	...	...	1700	.....
PENTAGONASTERIDÆ.								
PENTAGONASTERINÆ.								
Pentagonaster lepidus	...	...	+	...	...	...	1000	.....
Chitonaster cataphractus	...	...	...	+	...	...	1975	.....
Nymphaster protentus	...	...	...	+	...	...	1525	.....
Nymphaster basilicus	...	...	+	...	...	...	1200	.....
Paragonaster cylindratus	...	...	...	+	...	...	1850	.....
MIMASTERINÆ.								
Mimaster cognatus	...	...	+	...	...	...	1325	Also Continental.
GYMNASTERIIDÆ.								
Porania antarctica	...	...	...	+	...	...	1600	Also Littoral.
Porania spiculata	...	+	...	...	...	...	800	Also Littoral.
ZOROASTERIDÆ.								
Zoroaster fulgens	+	...	+	...	...	...	1350	.....
Zoroaster tenuis	...	...	+	...	...	...	1070	.....
Cnemidaster wyvillii	...	+	...	...	...	...	800	.....
STICHASTERIDÆ.								
Neomorphaster eustichus	...	+	+	...	...	...	1000	.....
SOLASTERIDÆ.								
SOLASTERINÆ.								
Solaster torulatus	+	...	...	...	...	...	520	.....
Lophaster stellans	...	...	+	...	...	...	1325	Also Littoral and Continental.
PTERASTERIDÆ.								
PTERASTERINÆ.								
Marsipaster spinosissimus	...	...	...	...	+	...	2335	.....
Marsipaster hirsutus	...	...	...	...	+	...	2160	.....
Hymenaster nobilis	...	...	...	+	...	...	1800	.....
Hymenaster formosus	...	...	...	+	...	...	1800	.....
Hymenaster pergamentaceus	...	...	...	...	...	+	2650	.....
Hymenaster sacculatus	...	...	...	+	...	...	1800	.....
Hymenaster echinulatus	...	...	...	...	+	...	2335	.....
Hymenaster carnosus	...	...	...	+	...	...	1500	.....
Hymenaster glaucus	+	...	...	...	...	...	565	.....
Hymenaster vicarius	...	...	+	...	...	...	1375	.....
Hymenaster infernalis	...	...	...	...	...	+	2900	.....
Hymenaster cælatus	...	...	...	+	...	...	1800	.....
Hymenaster crucifer	...	...	...	+	...	...	1800	.....
Hymenaster anomalus	...	...	+	...	...	...	1425	.....
Hymenaster latebrosus	...	...	...	+	...	...	1950	.....
Hymenaster porosissimus	...	...	+	...	...	...	1375	.....
Hymenaster graniferus	...	...	+	...	...	...	1375	.....
Hymenaster geometricus	...	...	...	...	+	...	2335	.....

	At or greater than						Greatest Depth recorded.	Occurrence in other Zones.
	500	750	1000	1500	2000	2500		
Pterasteridæ.								
Pterasterinæ.								
Hymenaster pullatus	...	...	+	...	...	...	1070	.....
Hymenaster membranaceus	...	...	+	...	...	...	1125	.....
Hymenaster coccinatus	...	...	+	...	...	...	1375	.....
Hymenaster præcoquis	...	...	+	+	...	...	1600	.....
Benthaster wyville-thomsoni	...	...	...	...	...	+	2900	.....
Benthaster penicillatus	...	...	+	...	...	...	1070	.....
Pythonasterinæ.								
Pythonaster murrayi	...	...	...	+	...	...	1900	.....
Echinasteridæ.								
Echinasterinæ.								
Cribrella oculata	...	...	+	...	...	...	1350	Also Littoral.
Cribrella sufflata	+	...	...	...	...	...	520	.....
Asteriidæ.								
Asterias vesiculosa	...	+	...	...	...	...	800	.....
Asterias (Hydrasterias) ophidion	...	...	+	...	...	...	1250	.....
Brisingidæ.								
Labidiaster annulatus	...	+	...	...	...	...	800	Also Littoral.
Brisinga verticillata	...	...	+	...	...	...	1350	.....
Brisinga armillata	...	...	...	+	...	...	1875	.....
Brisinga membranacea	...	...	+	+	...	...	1600	.....
Brisinga discincta	...	...	...	...	...	+	2600	.....
Freyella pennata	...	...	...	+	...	...	1875	.....
Freyella polycnema	+	...	...	...	...	...	600	.....
Freyella echinata	...	...	+	+	+	...	2150	.....
Freyella fragilissima	...	...	+	+	...	...	1975	.....
Freyella bracteata	...	...	+	...	...	...	1350	.....
Freyella dimorpha	...	...	+	...	...	...	1400	.....
Freyella remex	...	...	...	...	+	...	2440	.....
Freyella tuberculata	...	...	...	...	+	...	2400	.....
Freyella benthophila	...	...	...	...	...	+	2550	.....
Freyella heroina	...	...	...	...	...	+	2900	.....
Freyella attenuata	...	...	...	...	+	...	2300	.....
Colpaster scutigerula	...	...	...	+	...	...	1525	.....

The above table comprises 109 species and varieties found in the Abyssal Zone. Of these, 3 pass into the Continental Zone, and 9 into the Littoral Zone.

Zone unknown.

The depth at which the following species collected by the Challenger were dredged is not recorded. Those marked with an asterisk have been found previously in the Littoral Zone.

Pontaster venustus, var. *robusta.*
Pseudarchaster tessellatus.
Psilaster cassiope.
Psilaster patagiatus.
**Luidia africana.*
**Pentagonaster semilunatus.*
**Pentagonaster astrologorum.*
Nymphaster albidus.
**Pentaceros dorsatus.*
**Asterina folium.*
**Linckia guildingii.*
**Narcissia canariensis.*
Narcissia trigonaria.
**Asterias (Stolasterias) glacialis.*

II. "PORCUPINE" EXPEDITIONS.

(1.) Littoral Zone.

Species found in depths which extend from the Shore to 150 *fathoms.*

	Depth in Fathoms.	Occurrence in other Zones.
Archasteridæ.		
Pararchasterinæ.		
Pontaster tenuispinus, var. *platynota*	150	Also Continental.
Pontaster limbatus	150	Also Continental.
Astropectinidæ.		
Astropectininæ.		
Astropecten irregularis	75	Also Continental.
Luidiinæ.		
Luidia africana	128	.....
Luidia sarsii	75	Also Continental.
Antheneidæ.		
Hippasteria plana	100	.....
Gymnasteriidæ.		
Porania pulvillus	106	.....
Echinasteridæ.		
Echinasterinæ.		
Cribrella oculata	125	Also Continental.
Asteriidæ.		
Asterias (*Leptasterias*) *müller*i	75	Also Continental.

(2.) Continental Zone.

Species found in depths between 150 *fathoms and* 500 *fathoms.*

	Depth in Fathoms.	Occurrence in other Zones.
Archasteridæ.		
Pararchasterinæ.		
Pontaster tenuispinus	458	.....
Pontaster tenuispinus, var. *platynota*	363	Also Littoral.
Pontaster limbatus	440	Also Littoral.
Porcellanasteridæ.		
Ctenodiscinæ.		
Ctenodiscus corniculatus	312	Also Abyssal.
Astropectinidæ.		
Astropectininæ.		
Leptoptychaster arcticus	345	Also Abyssal.
Astropecten irregularis	374	Also Littoral.
Psilaster andromeda	344	Also Abyssal.
Bathybiaster vexillifer	344	.....
Luidiinæ.		
Luidia sarsii	374	Also Littoral.
Pentagonasteridæ.		
Pentagonasterinæ.		
Pentagonaster granularis	440	.....

	Depth in Fathoms.	Occurrence in other Zones.
Solasteridæ.		
Solasterinæ.		
Crossaster papposus	384	Also Abyssal.
Lophaster furcifer	384	Also Abyssal.
Echinasteridæ.		
Echinasterinæ.		
Cribrella oculata	458	Also Littoral.
Asteriidæ.		
Asterias (Leptasterias) müllerii	312	Also Littoral.
Brisingidæ.		
Odinia pandina	440	.....
Brisinga endecacnemos	469	Also Abyssal.
Brisinga coronata	458	Also Abyssal.

(3.) Abyssal Zone.

Species found in depths greater than 500 *fathoms.*

	At or greater than						Greatest Depth recorded.	Occurrence in other Zones.
	500	750	1000	1500	2000	2500		
Archasteridæ.								
Plutonasterinæ.								
Plutonaster bifrons	+	...	+	...	...	...	1360	.....
Plutonaster (Tethyaster) parelii	...	...	+	...	...	...	1360	.....
Porcellanasteridæ.								
Ctenodiscinæ.								
Ctenodiscus corniculatus	+	...	...	...	...	...	632	Also Continental.
Astropectinidæ.								
Astropectininæ.								
Leptoptychaster arcticus	+	...	...	...	...	...	690	Also Continental.
Psilaster andromeda	+	...	...	...	...	...	690	Also Continental.
Gymnasteriidæ.								
Marginaster fimbriatus	...	...	+	...	...	...	1360	.....
Lasiaster villosus	+	...	...	...	...	...	542	.....
Zoroasteridæ.								
Zoroaster fulgens	...	+	...	...	...	...	767	.....
Solasteridæ.								
Solasterinæ.								
Crossaster papposus	+	...	...	...	...	...	640	Also Continental.
Lophaster furcifer	+	...	...	...	...	...	605	Also Continental.
Korethrasterinæ.								
Korethraster hispidus	+	...	...	...	...	...	632	.....
Pterasteridæ.								
Pterasterinæ.								
Hymenaster pellucidus	+	...	...	...	...	...	580	.....
Brisingidæ.								
Brisinga endecacnemos	+	...	+	...	...	...	1095	Also Continental.
Brisinga coronata	+	...	...	...	...	...	630	Also Continental.

The following species were also collected by the "Porcupine," but the depth is not recorded:—

Palmipes membranaceus. | *Chætaster longipes.* | *Stichaster roseus.*

III. "KNIGHT ERRANT" EXPEDITION.

(1.) Littoral Zone.

Species found in depths which extend from the Shore to 150 *fathoms.*

	Depth in Fathoms.	Occurrence in other Zones.
Astropectinidæ.		
Luidiinæ.		
Luidia sarsii	53	.....
Gymnasteriidæ.		
Porania pulvillus	53	.....
Solasteridæ.		
Solasterinæ.		
Crossaster papposus	53	.....
Echinasteridæ.		
Echinasterinæ.		
Cribrella oculata	53	.....
Asteriidæ.		
Asterias rubens	53	.....
Asterias (*Leptasterias*) *müllerì*	53	.....

(2.) Continental Zone.

Crossaster papposus, var. *septentrionalis* . . . 375 fathoms.

(3.) Abyssal Zone.

Species found in depths greater than 500 *fathoms.*

	At or greater than						Greatest Depth recorded.	Occurrence in other Zones.
	500	750	1000	1500	2000	2500		
Archasteridæ.								
Pararchasterinæ.								
Pontaster tenuispinus, var. *platynota* .	+	...	...	...	...	...	540	.....
Plutonasterinæ.								
Plutonaster bifrons	+	...	...	...	...	...	540	.....
Astropectinidæ.								
Astropectininæ.								
Psilaster andromeda	+	...	...	...	...	...	530	.....
Pentagonasteridæ.								
Mimasterinæ.								
Mimaster tizardi	+	...	...	...	...	...	555	.....

IV. "TRITON" EXPEDITION.

(1.) Littoral Zone.

Species found in depths which extend from the Shore to 150 *fathoms.*

	Depth in Fathoms.	Occurrence in other Zones.
Astropectinidæ.		
Luidiinæ.		
Luidia ciliaris	87	.....
Antheneidæ.		
Hippasteria plana	87	.....

(2.) Continental Zone.

Species found in depths between 150 *fathoms and* 500 *fathoms.*

	Depth in Fathoms.	Occurrence in other Zones.
Gymnasteriidæ.		
Rhegaster murrayi	433	.....
Echinasteridæ.		
Echinasterinæ.		
Cribrella oculata	240	Also Abyssal.
Asteriidæ.		
Asterias (*Leptasterias*) *mülleri*	433	.....

(3.) Abyssal Zone.

Species found in depths greater than 500 *fathoms.*

	At or greater than						Greatest Depth recorded.	Occurrence in other Zones.
	500	750	1000	1500	2000	2500		
Archasteridæ.								
Pararchasterinæ.								
Pontaster tenuispinus, var. *platynota* . .	+	...	...	...	...	...	608	.....
Plutonasterinæ.								
Plutonaster bifrons	+	...	...	...	...	...	555	.....
Astropectinidæ.								
Astropectininæ.								
Psilaster andromeda	+	...	...	...	...	...	555	.....
Pentagonasteridæ.								
Mimasterinæ.								
Mimaster tizardi	+	...	...	...	...	...	555	.....
Zoroasteridæ.								
Zoroaster fulgens	+	...	...	...	...	...	570	.....
Pterasteridæ.								
Pterasterinæ.								
Pteraster militaris	+	...	...	...	...	...	530	.....
Pteraster militaris, var. *prolata* . .	+	...	...	...	...	...	608	.....
Echinasteridæ.								
Echinasterinæ.								
Cribrella oculata, var. (see p. 543) . .	+	...	...	...	...	...	555	Also Continental.

Table showing the known Bathymetrical Range of the Genera of Asteroidea collected by the Challenger in each of the great Oceanic Areas.

	I. North Atlantic.	II. South Atlantic.	III. Indian Ocean.	IV. Southern Ocean.	V. Eastern Archipelago.	VI. North Pacific.	VII. South Pacific.
PHANEROZONIA.							
Archasteridæ.							
Pararchasterinæ.							
Pararchaster . .	1240–1700	425	...	1600–1900	...	565–1875	...
Pontaster . . .	70–2025	2650	...	1375	100–800	345–1050	245–950
Plutonasterinæ.							
Dytaster . . .	1106–2025	1900–2650	...	...	800–2150	2050	1375
Plutonaster .	210–1360 or 1700	425	...	...	...	...	950
— *Tethyaster* .	50–1608	...	...	...	...	...	...
Lonchotaster . .	2400	...	...	1950–1975	...	...	...
Pseudarchasterinæ.							
Pseudarchaster .	85	?	...	...	...	...	147
Aphroditaster . .	1000	...	...	...	...	...	...
Archasterinæ.							
Archaster . . .	...	...	Shallow water	...	?	...	0–250
Porcellanasteridæ.							
Porcellanasterinæ.							
Porcellanaster . .	784–1917	2550	...	...	800	1875	2225–2335
Styracaster . . .	1637–1987	2350	...	...	...	1850	...
Hyphalaster . .	1637–2617	...	...	1950	...	1875	2160–2750
Thoracaster . .	2400	...	...	...	...	...	...
Ctenodiscinæ.							
Ctenodiscus . .	7–632	55–600	...	...	...	...	40–1325
Astropectinidæ.							
Astropectininæ.							
Craspidaster . .	...	...	...	...	20	10	...
Leptoptychaster .	20–1350	...	...	10–210	...	...	...
Astropecten . .	2–450	5–400	?	?	6–140	2–345	2–50
Psilaster . . .	40–690	Shallow water	...	...	...	1875	150–950
Phoxaster . . .	1240–1700	...	...	...	...	...	...
Bathybiaster . .	344–1215	...	...	75–127	...	...	245
Luidiinæ.							
Luidia	7–374	7–20	?	...	6–115	5–25	150
Pentagonasteridæ.							
Pentagonasterinæ.							
Pentagonaster . .	3–1323	55	?	...	3–11	345	245
Calliaster . . .	...	5–18	...	...	...	?	...
Chitonaster . .	...	...	...	1975	...	...	...
Gnathaster . . .	...	9–55	...	5–150	?	...	0–30
Nymphaster . .	84–1525	1200	...	...	28–140	...	150
Paragonaster . .	1850	...	...	...	140	...	...
Nectria	...	...	...	30–40	...	...	?
Goniodiscinæ.							
Stellaster . . .	...	...	60	..	4–36	?	...
Leptogonaster . .	...	...	...	...	100–115	...	...
Mimasterinæ.							
Mimaster . . .	516–555	...	...	...	...	...	245–1325

	I. North Atlantic.	II. South Atlantic.	III. Indian Ocean.	IV. Southern Ocean.	V. Eastern Archipelago.	VI. North Pacific.	VII. South Pacific.
PHANEROZONIA.							
Antheneidæ.							
Anthenea	...	...	5	...	6	?	6–15
Hippasteria	30–150	...	...	...	...	...	...
Pentacerotidæ.							
Pentaceros	?	?	?	...	6–28	?	?
Pentaceropsis	...	...	?	...	Shallow water	...	...
Culcita	...	...	?	?	10	?	?
Asterodiscus	...	...	...	...	10	?	...
Choriaster	...	...	...	...	10	Shallow water	Shallow water
Gymnasteriidæ.							
Gymnasteria	...	...	Shallow water	...	Shallow water	Shallow water	Shallow water
Porania	15–373	?	...	30–1600	800	...	45
Marginaster	54–1360	...	...	...	...	...	...
Rhegaster	5–658	...	...	...	...	...	...
Lasiaster	107–542	...	...	...	...	...	...
Asterinidæ.							
Ganeriinæ.							
Cycethra	...	12–55	...	...	...	...	30
Ganeria	...	55	...	...	...	...	...
Asterininæ.							
Patiria	...	Shallow water	?	...	...	...	?
Nepanthia	...	...	...	...	2–400	...	0–4
Asterina	0–140	Shallow water	?	?	10	5–50	6–10
Palmipedinæ.							
Palmipes	20–100	...	?	...	....	?	150
CRYPTOZONIA.							
Linckiidæ.							
Chætasterinæ.							
Chætaster	30–450	...	...	...	...	...	...
Linckiinæ.							
Fromia	...	...	Shallow water	...	Shallow water	Shallow water	Shallow water
Ophidiaster	5–450	...	Shallow water	...	0–8	?	Shallow water
Leiaster	...	...	?	...	?	?	Shallow water
Linckia	Shallow water	?	Shallow water	...	7–36	Shallow water	Shallow water
Nardoa	...	...	?	...	Shallow water	40	?
Narcissia	?	?	...	...	...	...	...
Metrodirinæ.							
Metrodira	...	...	...	...	8	?	?
Zoroasteridæ.							
Zoroaster	38–2326	675	...	...	...	...	1070
Cnemidaster	...	...	...	...	800	...	...
Pholidaster	...	...	...	...	100–140	...	...

	I. North Atlantic.	II. South Atlantic.	III. Indian Ocean.	IV. Southern Ocean.	V. Eastern Archipelago.	VI. North Pacific.	VII. South Pacific.
CRYPTOZONIA.							
Stichasteridæ.							
Stichaster . . .	2–782	150	...	...	...	...	0–245
Neomorphaster .	900–1000	...	...	...	...	...	...
Tarsaster . . .	...	...	...	...	...	...	150
Solasteridæ.							
Solasterinæ.							
Crossaster . . .	0–640	...	...	140	...	...	?
Rhipidaster . .	...	...	...	...	28	...	...
Solaster . . .	0–1537	...	...	150	...	345	175–520
Lophaster . . .	30–743	...	...	...	...	...	40–1325
Korethrasterinæ.							
Korethraster . .	56–670	...	...	...	...	...	...
Peribolaster . .	...	...	...	...	...	...	45
Pterasteridæ.							
Pterasterinæ.							
Pteraster	10–2021	30 (?)	..	28–150	...	?	245
Retaster . . .	124–640	55	?	127	6–25	...	245
Marsipaster . .	2192	...	...	...	...	...	2160–2335
Calyptraster . .	...	350	...	...	...	...	...
Hymenaster . .	70–2214	1425–2650	...	1375–1950	...	565–2900	1070–2335
Benthaster . . .	...	...	...	...	...	2900	1070
Pythonasterinæ.							
Pythonaster . .	...	1900	...	...	...	...	...
Echinasteridæ.							
Acanthasterinæ.							
Acanthaster . .	...	...	Shallow water	...	Shallow water	Shallow water	Shallow water
Mithrodiinæ.							
Mithrodia . . .	...	39	Shallow water	...	Shallow water	Shallow water	Shallow water
Echinasterinæ.							
Cribrella . . .	0–1350	0–150	...	10–310	...	40	245–520
Perknaster . . .	...	...	...	25–127	...	...	...
Echinaster . . .	10–309	7–20	?	28–127	?	?	16–25
Heliasteridæ.							
Heliaster . . .	...	...	...	....	...	Shallow water	Shallow water
Pedicellasteridæ.							
Pedicellaster . .	25–1808	14	...	20–140	...	...	...
Asteriidæ.							
Asterias . . .	0–860	9–63	?	10–127	800	5–50	0–597
— *Cosmasterias*	...	...	...	...	...	...	45–345
— *Smilasterias*	...	...	...	50–150	...	...	...
— *Hydrasterias*	1250	...	...	...	...	...	...
— *Leptasterias*	53–433	...	...	...	...	...	...
— *Stolasterias* .	0–174	0–150	?	...	95	345	0–38
Calvasterias . .	...	5–10	...	...	?	...	?
Brisingidæ.							
Labidiaster . .	...	55	...	75–150	800	...	...
Odinia . . .	440–784	...	...	...	...	...	...
Brisinga . . .	100–2021	...	...	1375–2600	...	1875	...
Freyella . . .	175–2733	2350	...	1375–1975	1050–2150	1675–2900	600–2550
Colpaster . . .	1525	...	...	...	...	...	...

C.—NATURE OF THE SEA-BOTTOM

On which the Asteroidea collected by the Challenger were found, with an enumeration of the Species occurring on each deposit.

I. TERRIGENOUS DEPOSITS.

a. Gravel, Stones.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Archasteridæ.				
Pararchasterinæ.				
Pontaster hebitus	+	...	...	.....
Pseudarchasterinæ.				
Pseudarchaster intermedius	+	...	...	.....
Astropectinidæ.				
Astropectininæ.				
Leptoptychaster arcticus, var. *elongata*	+	...	...	Also Blue mud.
Pentagonasteridæ.				
Pentagonasterinæ.				
Pentagonaster granularis	+	...	...	.....
Antheneidæ.				
Hippasteria plana	+	...	...	...
Stichasteridæ.				
Stichaster albulus	+	...	...	.....
Pterasteridæ.				
Pterasterinæ.				
Pteraster militaris	+	...	...	.....
Echinasteridæ.				
Echinasterinæ.				
Cribrella oculata	+	...	...	Also Rock and Blue mud.
Asteriidæ.				
Asterias (*Leptasterias*) *compta*	+	...	...	.....

b. Coarse Gravel.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Pentagonasteridæ.				
Pentagonasterinæ.				
Gnathaster meridionalis	+	...	...	Also Volcanic mud and Greenish Volcanic mud.
Gnathaster elongatus	+	...	...	
Gymnasteriidæ.				
Porania spiculata	+	...	...	Also Green mud and Volcanic mud.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Solasteridæ.				
Solasterinæ.				
Solaster subarcuatus	+	...	...	.....
Pterasteridæ.				
Pterasterinæ.				
Pteraster rugatus	+	...	...	.....
Asteriidæ.				
Asterias (Smilasterias) triremis	+	...	...	.....
Brisingidæ.				
Labidiaster annulatus	+	...	...	Also Green mud, Volcanic mud, and Greenish Volcanic mud.

c. Sand.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Porcellanasteridæ.				
Ctenodiscinæ.				
Ctenodiscus australis	+	...	...	Also Green sand.
Astropectinidæ.				
Astropectininæ.				
Astropecten pectinatus	+	...	...	Also Sand and Shells.
Astropecten japonicus	+	...	...	Also Mud and Blue mud.
Pentagonasteridæ.				
Pentagonasterinæ.				
Pentagonaster patagonicus	+	...	...	Also Blue mud.
Gnathaster pilulatus	+	...	...	.....
Pentacerotidæ.				
Pentaceros turritus	+	...	...	Also Green mud, Coral mud, and Coral Reefs.
Pentaceros productus, var. *tuberata*	+	...	...	.....
Culcita novæ-guineæ	+	...	...	Also Coral Reefs.
Asterinidæ.				
Ganeriinæ.				
Cycethra nitida	+	...	...	.....
Cycethra pinguis	+	...	...	.....
Ganeria falklandica	+	...	...	.....
Pterasteridæ.				
Pterasterinæ.				
Retaster verrucosus	+	...	...	.....
Asteriidæ.				
Asterias versicolor	+	...	...	.....
Asterias cunninghami	+	...	...	Also Sand, gravel.
Asterias glomerata	+	...	...	Also Sand, gravel.
Brisingidæ.				
Labidiaster radiosus	+	...	...	.....

d. Sand, Gravel.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Asterinidæ.				
Ganeriinæ.				
Cycethra electilis	+	...	...	.....
Echinasteridæ.				
Echinasterinæ.				
Cribrella obesa	+	...	...	Also Blue mud.
Asteriidæ.				
Asterias glomerata	+	...	...	Also Sand.
Asterias cunninghami	+	...	...	Also Sand.
Calvasterias stolidota	+	...	...	.....

e. Sand and Shells.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Astropectinidæ.				
Astropectininæ.				
Astropecten pectinatus	+	...	...	Also Sand.
Pentagonasteridæ.				
Pentagonasterinæ.				
Nectria ocellifera	+	...	...	.....
Stichasteridæ.				
Stichaster polyplax	+	...	...	.....
Asteriidæ.				
Asterias (Stolasterias) calamaria	+	...	...	.....

f. Rock.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Solasteridæ.				
Solasterinæ.				
Crossaster papposus	+	...	...	.....
Solaster endeca	+	...	...	.....
Echinasteridæ.				
Echinasterinæ.				
Cribrella oculata	+	...	...	Also Gravel, stones, and Blue mud.

g. Hard Ground, "Gravel, Shells."

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Astropectinidæ.				
Astropectininæ.				
Leptoptychaster antarcticus	...	+	...	.....
Echinasteridæ.				
Echinasterinæ.				
Cribrella præstans	...	+	...	.....
Cribrella simplex	...	+	...	Also Volcanic mud.

h. Hard Ground.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Pentagonasteridæ.				
Pentagonasterinæ.				
Nymphaster protentus	...	...	+	.....
Brisingidæ.				
Freyella polycnema	...	...	+	.....
Colpaster scutigerula	...	...	+	.....

i. Mud.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Astropectinidæ.				
Astropectininæ.	...			
Craspidaster hesperus	+	...	...	...
Astropecten japonicus	+	...	...	Also Sand and Blue mud.
Astropecten monacanthus	+	...	...	.....
Luidiinæ.				
Luidia longispina	+	...	...	.....

j. Blue Mud.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Archasteridæ.				
Pararchasterinæ.				
Pararchaster semisquamatus	...	...	+	Also Green mud.
Pararchaster semisquamatus, var. *occidentalis*	...	...	+	.....
Pararchaster antarcticus	...	...	+	.....
Pararchaster armatus	...	...	+	.....
Pontaster planeta	...	+	...	.....
Pontaster teres	+	...	...	.....
Pontaster forcipatus	...	...	+	.....
Pontaster pristinus	...	...	+	.....
Pontaster trullipes	...	...	+	.....
Plutonasterinæ.				
Dytaster exilis, var. *carinata*	...	...	+	.....
Dytaster madreporifer	...	...	+	.....
Dytaster nobilis	...	...	+	.....
Dytaster inermis	...	...	+	.....
Plutonaster bifrons	...	...	+	Also Globigerina ooze.
Plutonaster rigidus	...	...	+	.....
Plutonaster rigidus, var. *semiarmata*	...	...	+	.....
Pseudarchasterinæ.				
Pseudarchaster discus	+	...	...	.....
Porcellanasteridæ.				
Porcellanasterinæ.				
Porcellanaster cæruleus	...	...	+	.....
Porcellanaster tuberosus	...	...	+	.....
Porcellanaster gracilis	...	...	+	.....
Hyphalaster diadematus	...	...	+	.....
Hyphalaster inermis	...	...	+	.....
Ctenodiscinæ.				
Ctenodiscus procurator	+	+	+	.....
Astropectinidæ.				
Astropectininæ.				
Leptoptychaster arcticus, var. *elongata*	...	...	+	Also Gravel, stones.
Astropecten acanthifer	+	...	...	.....
Astropecten japonicus	+	...	...	Also Sand and Mud.
Psilaster acuminatus	+	...	...	Also Green mud.
Psilaster gracilis	...	...	+	.....
Phoxaster pumilus	...	...	+	.....
Bathybiaster loripes	...	+	...	.....
Pentagonasteridæ.				
Pentagonasterinæ.				
Pentagonaster patagonicus	...	+	...	Also Sand.
Nymphaster symbolicus, var. *breviradiata*	+	...	...	.....
Paragonaster ctenipes	+	...	...	.....
Goniodiscinæ.				
Stellaster incei	+	...	...	Also Green mud and Coral mud.
Mimasterinæ.				
Mimaster cognatus	...	+	+	.....

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Zoroasteridæ.				
Zoroaster fulgens	...	...	+	Also Red mud.
Zoroaster tenuis	...	...	+	.....
Pholidaster distinctus	+	...	...	.....
Stichasteridæ.				
Stichaster polygrammus	...	+	...	.....
Solasteridæ.				
Solasterinæ.				
Solaster regularis	...	+	...	.....
Lophaster stellans	+	+	+	.....
Pterasteridæ.				
Pterasterinæ.				
Pteraster stellifer	...	+	...	.....
Retaster gibber	...	+	...	.....
Marsipaster hirsutus	...	...	+	.....
Hymenaster pergamentaceus	...	...	+	.....
Hymenaster pullatus	...	...	+	.....
Hymenaster membranaceus	...	...	+	.....
Benthaster penicillatus	...	...	+	.....
Pythonasterinæ.				
Pythonaster murrayi	...	...	+	.....
Echinasteridæ.				
Echinasterinæ.				
Cribrella oculata	...	...	+	Also Gravel, stones, and Rock.
Cribrella obesa	...	+	...	Also Sand, gravel.
Asteriidæ.				
Asterias (Hydrasterias) ophidion	...	...	+	.....
Asterias (Cosmasterias) sulcifera	...	+	...	.....
Brisingidæ.				
Brisinga verticillata	...	...	+	.....
Brisinga armillata	...	...	+	.....
Freyella pennata	...	...	+	.....
Freyella echinata	...	...	+	Also Globigerina ooze.
Freyella bracteata	...	...	+	.....

k. Green Mud.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Archasteridæ.				
Pararchasterinæ.				
Pararchaster semisquamatus	...	...	+	Also Blue mud.
Pontaster oxyacanthus	...	+	...	.....
Pontaster mimicus	...	...	+	.....
Pontaster subtuberculatus	...	...	+	.....

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Archasteridæ.				
Plutonasterinæ.				
Dytaster æquivocus	...	...	+	.....
Plutonaster ambiguus	...	...	+	.....
Archasterinæ.				
Archaster typicus	...	+	...	Also Coral Reefs.
Porcellanasteridæ.				
Porcellanasterinæ.				
Porcellanaster caulifer	...	...	+	.....
Astropectinidæ.				
Astropectininæ.				
Astropecten brevispinus	...	+	...	.....
Astropecten imbellis	+	...	...	.....
Astropecten granulatus	+	...	...	.....
Psilaster acuminatus	...	...	+	Also Blue mud.
Luidiinæ.				
Luidia aspera	+	...	...	Also Coral mud.
Luidia forficifer	+	...	...	Also Coral mud.
Pentagonasteridæ.				
Pentagonasterinæ.				
Pentagonaster japonicus	...	+	...	.....
Pentagonaster arcuatus	...	+	...	.....
Nymphaster symbolicus	+	...	...	.....
Goniodiscinæ.				
Stellaster incei	+	...	...	Also Blue mud and Coral mud.
Leptogonaster cristatus	+	...	...	.....
Pentacerotidæ.				
Pentaceros turritus	+	...	...	Also Sand, Coral mud, and Coral Reefs.
Gymnasteriidæ.				
Porania spiculata	...	...	+	Also Coarse gravel and Volcanic mud.
Asterinidæ.				
Asterininæ.				
Nepanthia maculata	+	...	...	.....
Zoroasteridæ.				
Cnemidaster wyvillii	...	...	+	.....
Pholidaster squamatus	+	...	...	.....
Solasteridæ.				
Solasterinæ.				
Rhipidaster vannipes	+	...	...	.....
Solaster paxillatus	...	+	...	.....
Pterasteridæ.				
Pterasterinæ.				
Retaster insignis	+	...	...	Also Coral mud.
Hymenaster glaucus	...	...	+	.....
Asteriidæ.				
Asterias vesiculosa	...	...	+	.....
Asterias (Stolasterias) stichantha	...	+	...	.....
Brisingidæ.				
Labidiaster annulatus	...	...	+	Also Coarse gravel, Volcanic mud, and Greenish Volcanic mud.

l. Green Sand.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Porcellanasteridæ.				
Ctenodiscinæ.				
Ctenodiscus australis . . .	...	...	+	Also Sand.
Gymnasteriidæ.				
Porania magellanica . . .	+	...	...	.....
Stichasteridæ.				
Stichaster felipes	+	...	...	.....
Solasteridæ.				
Korethrasterinæ.				
Peribolaster folliculatus . . .	+	...	...	.....
Asteriidæ.				
Asterias (Cosmasterias) tomidata .	+	...	...	.....

m. Red Mud.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Astropectinidæ.				
Astropectininæ.				
Astropecten cingulatus . . .	+	+	...	.....
Pentagonasteridæ.				
Pentagonasterinæ.				
Nymphaster basilicus . . .	...	...	+	.....
Zoroasteridæ.				
Zoroaster fulgens	...	...	+	Also Blue mud.
Pterasteridæ.				
Pterasterinæ.				
Calyptraster coa	...	+	...	.....

n. Volcanic Mud.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Archasteridæ.				
Plutonasterinæ.				
Plutonaster abbreviatus . . .	...	...	+	.....
Pseudarchasterinæ.				
Aphroditaster gracilis . . .	...	...	+	.....
Astropectinidæ.				
Astropectininæ.				
Astropecten hermatophilus . .	...	+	...	.....
Bathybiaster loripes, var. *obesa* . .	+	...	...	Also Greenish Volcanic mud.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Pentagonasteridæ.				
Pentagonasterinæ.				
Pentagonaster lepidus	...	...	+	.....
Gnathaster meridionalis	+	...	...	Also Coarse gravel and Greenish Volcanic mud.
Gnathaster elongatus	+	...	...	
Gymnasteriidæ.				
Porania spiculata	+	...	...	Also Coarse gravel and Green mud.
Linckiidæ.				
Chætasterinæ.				
Chætaster longipes	...	+	...	Also Coral Reefs.
Linckiinæ.				
Ophidiaster attenuatus	...	+	...	.....
Ophidiaster ophidianus	...	+	...	.....
Solasteridæ.				
Solasterinæ.				
Solaster torulatus	...	...	+	.....
Pterasteridæ.				
Pterasterinæ.				
Pteraster affinis	+	...	...	.....
Echinasteridæ.				
Echinasterinæ.				
Cribrella sufflata	...	...	+	.....
Perknaster fuscus	+	...	...	Also Greenish Volcanic mud.
Asteriidæ.				
Asterias (Smilasterias) scalprifera	+	...	...	.....
Brisingidæ.				
Labidiaster annulatus	+	...	...	Also Coarse gravel, Green mud, and Greenish Volcanic mud.

o. Greenish Volcanic Mud.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Astropectinidæ.				
Astropectininæ.				
Leptoptychaster kerguelenensis	+	...	...	.....
Bathybiaster loripes, var. *obesa*	+	...	...	Also Volcanic mud.
Pentagonasteridæ.				
Pentagonasterinæ.				
Gnathaster meridionalis	+	...	...	Also Coarse gravel and Volcanic mud.
Gnathaster elongatus	+	...	...	
Gymnasteriidæ.				
Porania glaber	+	...	...	.....
Pterasteridæ.				
Pterasterinæ.				
Retaster peregrinator	+	...	...	.....

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Echinasteridæ.				
Echinasterinæ.				
Cribrella simplex, var. *granulosa*	+	...	...	.....
Perknaster fuscus	+	...	....	Also Volcanic mud.
Perknaster densus	+	...	...	.....
Echinaster spinulifer	+	...	...	.....
Pedicellasteridæ.				
Pedicellaster scaber	+	...	....	.....
Asteriidæ.				
Asterias perrieri	+	...	...	.....
Asterias meridionalis	+	...	...	.....
Brisingidæ.				
Labidiaster annulatus	+	...	...	Also Coarse gravel, Green mud, and Volcanic mud.

p. Volcanic Sand.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Archasteridæ.				
Pararchasterinæ.				
Pararchaster spinosissimus	...	+	...	.....
Plutonasterinæ.				
Plutonaster marginatus	...	+	...	.....
Solasteridæ.				
Solasterinæ.				
Crossaster penicillatus	+	...	...	.....
Echinasteridæ.				
Echinasterinæ.				
Cribrella simplex	...	+	...	Also Hard ground, Gravel, shells.
Pedicellasteridæ.				
Pedicellaster hypernotius	+	...	...	.....

q. Coral Mud.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Astropectinidæ.				
Astropectininæ.				
Astropecten zebra	+	...	...	.....
Astropecten zebra, var. *rosea*	+	...	...	.....
Luidiinæ.				
Luidia aspera	+	...	...	Also Green mud.
Luidia forficifer	+	...	...	Also Green mud.
Pentagonasteridæ.				
Pentagonasterinæ.				
Nymphaster bipunctus	+	...	...	.....
Goniodiscinæ.				
Stellaster incei	+	...	...	Also Blue mud and Green mud.
Stellaster princeps	+	...	...	.....

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Antheneidæ.				
Anthenea tuberculosa	+	...	...	.....
Pentacerotidæ.				
Pentaceros turritus	+	...	...	Also Sand, Green mud, and Coral Reefs.
Pentaceros callimorphus	+	...	...	.....
Asterinidæ.				
Asterininæ.				
Nepanthia brevis	+	...	...	.....
Palmipedinæ.				
Palmipes diaphanus	+	...	...	.....
Linckiidæ.				
Linckiinæ.				
Ophidiaster tuberifer	+	...	...	.....
Ophidiaster helicostichus	+	...	...	.....
Metrodirinæ.				
Metrodira subulata	+	...	...	.....
Stichasteridæ.				
Tarsaster stoichodes	+	...	...	.....
Pterasteridæ.				
Pterasterinæ.				
Retaster insignis	+	...	...	Also Green mud.

r. Coral Reefs.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Archasteridæ.				
Archasterinæ.				
Archaster typicus	+	...	...	Also Green mud.
Pentacerotidæ.				
Pentaceros turritus	+	...	...	Also Sand, Green mud, and Coral mud.
Pentaceropsis obtusatus	+	...	...	.....
Culcita novæ-guineæ	+	...	...	Also Sand.
Gymnasteriidæ.				
Gymnasteria carinifera	+	...	...	.....
Asterinidæ.				
Asterininæ.				
Asterina exigua	+	...	...	.....
Asterina cepheus	+	...	...	.....
Linckiidæ.				
Chætasterinæ.				
Chætaster longipes	+	...	...	Also Volcanic mud.
Linckiinæ.				
Fromia milleporella	+	...	...	.....
Ophidiaster cylindricus	+	...	...	.....
Leiaster speciosus	+	...	...	.....

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Linckiidæ.				
Linckiinæ.				
Linckia miliaris	+	...	...	.....
Linckia pacifica, var. *diplax*	+	...	...	.....
Nardoa tuberculata	+	...	...	.....
Echinasteridæ.				
Acanthasterinæ.				
Acanthaster echinites	+	...	...	.....
Mithrodiinæ.				
Mithrodia clavigera	+	...	...	.....
Asteriidæ.				
Asterias (*Stolasterias*) *tenuispina*	+	...	...	.....
Asterias (*Stolasterias*) *gemmifera*	+	...	...	.....

II. ABYSSAL DEPOSITS.

a. Globigerina Ooze.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Archasteridæ.				
Pararchasterinæ.				
Pararchaster pedicifer	...	...	+	Also Diatom ooze.
Pontaster forcipatus, var. *echinata*	...	...	+	.....
Pontaster venustus	...	...	+	Also Pteropod ooze.
Plutonasterinæ.				
Dytaster spinosus	...	...	+	.....
Dytaster exilis	...	...	+	.....
Dytaster exilis, var. *gracilis*	...	...	+	.....
Dytaster biserialis	...	...	+	.....
Plutonaster bifrons	...	...	+	Also Blue mud.
Lonchotaster tartareus	...	...	+	.....
Porcellanasteridæ.				
Porcellanasterinæ.				
Styracaster horridus	...	...	+	.....
Styracaster armatus	...	...	+	.....
Thoracaster cylindratus	...	...	+	.....
Pentagonasteridæ.				
Pentagonasterinæ.				
Paragonaster cylindratus	...	...	+	.....
Pterasteridæ.				
Pterasterinæ.				
Hymenaster nobilis	...	...	+	.....
Hymenaster formosus	...	...	+	.....
Hymenaster sacculatus	...	...	+	.....

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Pterasteridæ.				
Pterasterinæ.				
Hymenaster carnosus	...	...	+	.....
Hymenaster vicarius	...	...	+	.....
Hymenaster cælatus	...	...	+	.....
Hymenaster crucifer	...	...	+	.....
Hymenaster porosissimus	..	...	+	.....
Hymenaster graniferus	...	...	+	.....
Hymenaster coccinatus	...	...	+	.....
Hymenaster præcoquis	...	...	+	Also Diatom ooze.
Echinasteridæ.	...			
Echinasterinæ.				
Cribrella compacta	...	+	...	.....
Brisingidæ.	..			
Brisinga membranacea	...	...	+	Also Diatom ooze.
Freyella echinata	...	...	+	Also Blue mud.
Freyella fragilissima	...	...	+	Also Diatom ooze.
Freyella dimorpha	...	...	+	.....
Freyella tuberculata	...	...	+	.....

b. Pteropod Ooze.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Archasteridæ.				
Pararchasterinæ.				
Pontaster venustus	...	...	+	Also Globigerina ooze.
Plutonasterinæ.				
Plutonaster notatus	...	...	+	.....
Stichasteridæ.				
Neomorphaster eustichus	...	...	+	.....
Pterasteridæ.				
Pterasterinæ.				
Hymenaster anomalus	...	...	+	.....
Brisingidæ.				
Brisinga cricophora	...	+	...	.....

c. Diatom Ooze.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Archasteridæ.				
Pararchasterinæ.				
Pararchaster pedicifer	...	...	+	Also Globigerina ooze.
Plutonasterinæ.				
Lonchotaster forcipifer	...	...	+	.....

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Porcellanasteridæ.				
Porcellanasterinæ.				
Hyphalaster planus	...	...	+	.....
Pentagonasteridæ.				
Pentagonasterinæ.				
Chitonaster cataphractus	...	...	+	.....
Gymnasteriidæ.				
Porania antarctica	...	...	+	.....
Pterasteridæ.				
Pterasterinæ.				
Hymenaster latebrosus	...	...	+	.....
Hymenaster præcoquis	...	...	+	Also Globigerina ooze.
Brisingidæ.				
Brisinga membranacea	...	...	+	Also Globigerina ooze.
Freyella fragilissima	...	...	+	Also Globigerina ooze.

d. Radiolarian Ooze.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Porcellanasteridæ.				
Porcellanasterinæ.				
Hyphalaster hyalinus	...	...	+	.....
Brisingidæ.				
Freyella attenuata	...	...	+	.....

e. Red Clay.

	Bathymetrical Zone.			Occurrence on other Deposits.
	Littoral.	Continental.	Abyssal.	
Porcellanasteridæ.				
Porcellanasterinæ.				
Porcellanaster crassus	...	...	+	.....
Porcellanaster eremicus	...	...	+	.....
Pterasteridæ.				
Pterasterinæ.				
Marsipaster spinosissimus	...	...	+	.....
Hymenaster echinulatus	...	...	+	.....
Hymenaster infernalis	...	...	+	.....
Hymenaster geometricus	...	...	+	.....
Benthaster wyville-thomsoni	...	...	+	.....
Brisingidæ.				
Brisinga discincta	...	...	+	.....
Freyella remex	...	...	+	.....
Freyella benthophila	...	...	+	.....
Freyella heroina	...	...	+	.....

LIST OF THE KNOWN SPECIES OF RECENT ASTEROIDEA (SUB-CLASS

GEOGRAPHICAL AND BATHYMETRICAL

New species discovered by the Challenger are marked *.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
Order PHANEROZONIA, Sladen. Family *ARCHASTERIDÆ* (Viguier), Sladen. Subfamily PRARCHASTERINÆ, Sladen.				
Pararchaster, Sladen.				
**P. armatus*, Sladen	Off E. coast of N. America; off Portugal.	1250–1350	Blue mud.	(1)
**P. antarcticus*, Sladen	65° 42′ 0″ S., 79° 49′ 0″ E.	1675	Blue mud.	(2)
**P. pedicifer*, Sladen	Off Agulhas Bank; W. of Crozet Islands.	1600–1900	Diatom and Globigerina ooze.	(3)
**P. semisquamatus*, Sladen	S. of Japan.	565–1875	Blue mud; Green mud.	(4)
**P. semisquamatus*, var. *occidentalis*, Sladen	Off E. coast of N. America.	1240 or 1700	Blue mud.	(5)
P. simplex, Perrier, sp.	N. of Cuba.	1323	.....	(6)
**P. spinosissimus*, Sladen	Off Island of Ascension.	425	Volcanic sand.	(7)
Pontaster, Sladen.				
**P. forcipatus*, Sladen	Off E. coast of N. America.	1240–1700	Blue mud.	(8)
**P. forcipatus*, var. *echinata*, Sladen	Between Marion and the Crozet Islands.	1375	Globigerina ooze.	(9)

EUASTEROIDEA), WITH THE PRINCIPAL LOCALITIES, THE GENERAL DISTRIBUTION, AND THE SYNONYMS.

Previously known species collected by the Challenger are marked ×.

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	+	...	...	...	...	...	...	...	...	A	37°·2–38°·0	.....
(2)	...	...	...	+	...	...	...	...	...	A	...	.....
(3)	...	...	...	+	...	...	...	...	...	A	34°·2–35°·6	.....
(4)	...	...	...	...	...	+	...	...	...	A	35°·3–38°·1	.....
(5)	+	...	..	...	...	...	...	...	...	A	36°·2–37°·2	.....
(6)	+	...	...	...	...	...	...	...	...	A	40°·0	= *Archaster simplex*, Perrier.
(7)	...	+	...	...	...	...	...	...	C	...	40°·3	.....
(8)	+	...	...	...	...	...	...	...	...	A	36°·2–38°·0	.....
(9)	...	...	...	+	...	...	...	...	...	A	35°·6	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA. *Archasteridæ.* Pararchasterinæ.				
Pontaster, Sladen.				
**P. hebitus*, Sladen	Off E. coast of N. America	85	Gravel, stones.	(1)
P. limbatus, Sladen	Faeröe Channel; W. of Ireland; S.W. of Scilly Islds.	100–440	.....	(2)
**P. mimicus*, Sladen	Arafura Sea.	800	Green mud.	(3)
P. mirabilis, Perrier, sp.	West Indian area.	56–1030	Coral sand, broken shells, mud and hard ground.	(4)
**P. oxyacanthus*, Sladen	S. of Japan.	345	Green mud.	(5)
**P. planeta*, Sladen	W. of S. America.	245	Blue mud.	(6)
**P. pristinus*, Sladen	E. of S. America.	2650	Blue mud.	(7)
**P. subtuberculatus*, Sladen	E. of Australia.	950	Green mud.	(8)
P. tenuispinus, Düben and Koren, sp.	Faeröe Channel; Scandinavian coasts; Spitzbergen.	70–778	.....	(9)
P. tenuispinus, var. *platynota*, Sladen	Faeröe Channel; W. of Ireland.	100–608	.....	(10)
**P. teres*, Sladen	Banda Sea.	140	Blue mud.	(11)
**P. trullipes*, Sladen	W. of Luzon (Philippines).	1050	Blue mud.	(12)
**P. venustus*, Sladen	E. of Azores.	900–2025	Pteropod ooze; Globigerina ooze.	(13)
**P. venustus*, var. *robusta*, Sladen	Off Cape Verde Islands.	...	.....	(14)
P. (?) *coronatus*, Perrier, sp.	Off Morro-light; off Havana.	310–805	.....	(15)
P. (?) *echinulatus*, Perrier, sp.	Gulf of Mexico; off Cuba.	84–229	Corals and soft coralline ooze.	(16)
P. (?) *pulcher*, Perrier, sp.	St. Vincent.	573	Fine sand and mud.	(17)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
1)	+	...	...	...	...	...	...	L	...	...	35°·0	.....
(2)	+	...	...	...	...	...	...	L	C	...	41°·9–58°·6	.....
(3)	...	...	...	...	+	...	...	...	...	A	39°·5	.....
(4)	+	...	...	...	...	...	...	L	C	A	38°·5–74°·5	= *Archaster mirabilis*, Perrier; *Cheiraster mirabilis*, Perrier.
(5)	...	...	...	...	...	+	...	...	C	...	41°·1	.....
(6)	...	...	...	...	...	...	+	...	C	...	46°·0	.....
(7)	...	+	...	...	...	...	...	...	...	A	32°·7	.....
(8)	...	...	...	...	...	...	+	...	...	A	36°·5	.....
(9)	+	...	...	...	...	...	...	L	C	A	30°·0–45°·1	= *Astropecten tenuispinus*, Düben and Koren; *Archaster tenuispinus*, Sars.
	+	...	...	...	...	...	...	L	C	A	29°·2–30°·0	.....
1)	...	...	...	...	+	...	...	L	...	...	...	.....
12)	...	...	...	...	...	+	...	...	...	A	37°·0	.....
(13)	+	...	...	...	...	...	...	...	...	A	35°·9–40°·0	.....
(14)	+	...	...	...	...	...	...	...	...	?	...	.....
(15)	+	...	...	...	...	...	...	...	C	A	52°·5	= *Archaster coronatus*, Perrier.
	+	...	...	...	...	...	...	L	C	...	53°·5–68°·0	= *Archaster echinulatus*, Perrier.
(17)	+	...	...	...	...	...	...	...	...	A	42°·5	= *Archaster pulcher*, Perrier.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA.				
Archasteridæ.				
Subfamily Plutonasterinæ, Sladen.				
Dytaster, Sladen.				
**D. æquivocus*, Sladen . . .	Arafura Sea.	800	Green mud.	(1)
**D. biserialis*, Sladen . . .	Between Madeira and Azores.	2025	Globigerina ooze.	(2)
**D. exilis*, Sladen . . .	W. of S. America.	1375	Globigerina ooze.	(3)
**D. exilis*, var. *carinata*, Sladen .	Off coast of N. America.	1700	Blue mud.	(4)
**D. exilis*, var. *gracilis*, Sladen .	W. of Tristan da Cunha.	1900	Globigerina ooze.	(5)
**D. inermis*, Sladen . . .	N. of Celebes.	2150	Blue mud.	(6)
**D. madreporifer*, Sladen . .	Off coast of N. America.	1240–1700	Blue mud.	(7)
**D. nobilis*, Sladen . . .	E. of Buenos Ayres.	2650	Blue mud.	(8)
**D. spinosus*, Sladen . . .	36° 10′ 0″ N., 178° 0′ 0″ E.	2050	Globigerina ooze.	(9)
D. (?) *grandis*, Verrill, sp. . .	E. coast of N. America.	1106–2033	.....	(10)
Plutonaster, Sladen.				
**P. abbreviatus*, Sladen . .	Off the Azores.	1000	Volcanic mud.	(11)
**P. ambiguus*, Sladen . . .	E. of Australia (off Sydney).	950	Green mud.	(12)
×*P. bifrons*, Wyville Thomson, sp.	Faeröe Channel; coast of Portugal; Mediterranean (*fide* Milne-Edwards); N. America; Barent's Sea (*fide* Norman).	210–1360	Globigerina ooze; Blue mud.	(13)
**P. marginatus*, Sladen . .	Near Island of Ascension.	425	Volcanic sand.	(14)
**P. notatus*, Sladen . . .	Near the Azores.	1000	Pteropod ooze.	(15)
**P. rigidus*, Sladen . . .	E. of N. America.	1700 or 1240	Blue mud.	(16)
**P. rigidus*, var. *semiarmata*, Sladen	E. of N. America.	1340 or 1350	Blue mud.	(17)
P. (?) *agassizii*, Verrill, sp. . .	E. of N. America.	182–1342	.....	(18)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	...	...	...	...	+	...	...	...	...	A	39°·5	.....
(2)	+	...	...	...	...	...	...	...	...	A	35°·9	.....
(3)	...	...	...	...	...	...	+	...	...	A	35°·5	.....
(4)	+	...	...	...	...	...	...	...	...	A	36°·2	.....
(5)	...	+	...	...	...	...	...	...	...	A	35°·4	.....
(6)	...	...	...	...	+	...	...	...	...	A	38°·9	.....
(7)	+	...	...	...	...	...	...	...	...	A	36°·2–37°·2	.....
(8)	...	+	...	...	...	...	...	...	...	A	32°·7	.....
(9)	...	...	...	...	...	+	...	...	...	A	35°·1	.....
(10)	+	...	...	...	...	...	...	...	...	A	...	= *Archaster grandis*, Verrill.
(11)	+	...	...	...	...	...	...	...	...	A	...	.....
(12)	...	...	...	...	...	...	+	...	...	A	36°·5	.....
(13)	+	...	...	...	...	...	...	...	C	A	29°·2–38°·5	= *Archaster bifrons*, Wyville Thomson; *Goniopecten bifrons*, Perrier.
(14)	...	+	...	...	...	...	...	...	C	...	40°·3	.....
(15)	+	...	...	...	...	...	...	...	...	A	39°·4	.....
(16)	+	...	...	...	...	...	...	...	...	A	36°·2 or 37°·2	.....
(17)	+	...	...	...	...	...	...	...	...	A	37°·2	.....
(18)	+	...	...	...	...	...	...	...	C	A	...	= *Archaster agassizii*, Verrill.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA.				
Archasteridæ.				
Plutonasterinæ.				
Plutonaster, Sladen.				
Sub-gen. *Tethyaster*, Sladen.				
P. (T.) subinermis, Philippi, sp.	Mediterranean area; off Liberia (*fide* Studer).	50–100	.....	(1)
P. (T.) parelii, Düben and Koren, sp.	N. of Ireland; Finmark; Lofoten; coast of Norway; off Shetland; E. of N. America.	155–1608	Sandy clay.	(2)
P. (T.) parelii, var. *longobrachialis*, Danielssen and Koren	Off the coast of Norway.	115–220	Ooze and sandy clay.	(3)
Lonchotaster, Sladen.				
**L. forcipifer*, Sladen	62° 26′ 0″ S., 95° 44′ 0″ E. 53° 55′ 0″ S., 108° 35′ 0″ E.	1950–1975	Diatom ooze.	(4)
**L. tartareus*	Between the Canary and Cape Verde Islands.	2400	Globigerina ooze.	(5)
Subfamily Pseudarchasterinæ, Sladen.				
Pseudarchaster, Sladen.				
**P. discus*, Sladen	Messier Channel.	147	Blue mud.	(6)
**P. intermedius*	S. of Nova Scotia.	85	Gravel and stones.	(7)
**P. tessellatus*, Sladen	Simon's Bay (C. of Good Hope).	(?) Shallow.	?	(8)
Aphroditaster, Sladen.				
**A. gracilis*, Sladen	Off the Azores.	1000	Volcanic mud.	(9)
Subfamily Archasterinæ, Sladen.				
Archaster, Müller and Troschel, *emend.*				
A. angulatus, Müller and Troschel	Mauritius; Philippine Islands; Java (?); Port Darwin; Torres Strait; Freemantle, W. Australia; New Guinea; Fiji Islands (*fide* Studer).	Shallow.	.....	(10)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	+	...	...	...	...	...	...	L	...	...	...	= *Asterias subinermis*, Philippi; *Astropecten subinermis*, Müller and Troschel; *Archaster subinermis*, Perrier; *Goniopecten subinermis*, Perrier.
(2)	+	...	...	...	...	...	...	...	C	A	37°·2–44°·4	= *Astropecten parelii*, Düben and Koren; *Archaster parelii*, Sars.
(3)	+	...	...	...	...	...	...	L	C	...	35°·4–44°·9	.....
(4)	...	...	...	+	...	...	...	...	...	A	32°·1	.....
(5)	+	...	...	...	...	...	...	...	...	A	36°·6	.....
(6)	...	...	...	...	...	...	+	L	...	...	...	.....
(7)	+	...	...	...	...	...	...	L	...	...	35°·0	.....
(8)	...	+	...	...	...	...	...	?	...	...	...	.....
(9)	+	...	...	...	...	...	...	...	...	A	...	.....
(10)	...	...	+	...	+	...	+	L	...	...	...	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA.				
Archasteridæ.				
Archasterinæ.				
Archaster, Müller and Troschel, *emend.*				
×*A. typicus*, Müller and Troschel	Eastern Archipelago; Pelew Islands; New Guinea; Port Darwin; Port Essington; Cape Grenville; Port Denison; New Caledonia; Fiji and Tonga Islands; Nicobar Islands; Andaman Islands; Mergui; Japan (??).	Shallow to 250	Coral reefs; Green mud.	(1)
Archaster non sensu stricto:—				
A. americanus, Verrill . .	E. coast of N. America.	45–225	.....	(2)
A. bairdii, Verrill . . .	E. coast of N. America.	351–396	.....	(3)
A. efflorescens, Perrier . .	N. of Havana.	955	.....	(4)
A. floræ, Verrill[1] . . .	E. coast of N. America.	86–410	.....	(5)
A. formosus, Verrill . . .	E. coast of N. America.	1467–1608	.....	(6)
A. insignis, Perrier . . .	N. of Havana, W. of Tortugas.	1930	.....	(7)
A. robustus, Verrill . . .	E. coast of N. America.	938–1467	.....	(8)
A. sepitus, Verrill . . .	E. coast of N. America.	368–858	.....	(9)
Archasteridæ *incertæ sedis:*				
Benthopecten, Verrill.				
B. spinosus, Verrill . . .	E. coast of N. America.	855–1917	.....	(10)
Blakiaster, Perrier.				
B. conicus, Perrier . . .	Off Grenada; off Havana.	92–175	.....	(11)
Cheiraster, Studer.				
C. gazellæ, Studer . . .	N.W. Australia.	195	Grey mud.	(12)
C. pedicellaris, Studer . .	Off E. coast of Australia.	550	Globigerina ooze.	(13)
C. (?) *folini*, Perrier . . .	"Talisman" dredgings.	...	.....	(14)

[1] Probably either *Bathybiaster* or *Psilaster* (?).

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	...	+	...	+	+	+	L	C	...	...	Incl.: *Astropecten stellaris*, Gray; *Archaster nicobaricus*, Möbius.
(2)	+	...	...	...	...	...	...	L	C	...	...	I am unable to classify these species from the descriptions published; they are not referable to *Archaster* as now limited.
(3)	+	...	...	...	...	...	...	...	C	...	...	
(4)	+	...	...	...	...	...	...	...	...	A	39°·5	
(5)	+	...	...	...	...	...	...	L	C	...	...	
(6)	+	...	...	...	...	...	...	...	...	A	...	
(7)	+	...	...	...	...	...	...	...	...	A	39°·5	
(8)	+	...	...	...	...	...	...	...	...	A	...	
(9)	+	...	...	...	...	...	...	...	C	A	...	
(10)	+	...	...	...	...	...	...	...	...	A	...	.....
(11)	+	...	...	...	...	...	...	L	C	...	...	.....
(12)	...	...	+	...	...	...	...	...	C	...	...	.....
(13)	...	...	...	...	...	...	+	...	...	A	...	.....
(14)	+	...	...	...	...	...	...	...	...	...	...	Not yet described.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA. *Archasteridæ.* Archasterinæ.				
Crenaster, Perrier.				
C. marionis, Perrier	"Talisman" dredgings.	437–820	.....	(1)
C. mollis, Perrier	"Talisman" dredgings.	1092	.....	(2)
Goniopecten, Perrier.				
G. demonstrans, Perrier	Santa Cruz; Nevis.	355–451	Sand and grey mud.	(3)
G. edwardsi, Perrier	"Travailleur" dredging, No. 36.	1416	.....	(4)
G. inermis, Perrier	"Talisman" dredgings.	519–1092	.....	(5)
G. intermedius, Perrier	N. of Havana.	833–955	.....	(6)
G. subtilis, Perrier	N. of Havana.	1930	.....	(7)
Pectinaster, Perrier.				
P. filholi, Perrier	"Talisman" dredgings.	656–1366	.....	(8)
P. insignis, Perrier	"Talisman" dredgings.	2731	.....	(9)
Luidiaster, Studer.				
L. hirsutus, Studer	N.W. of Kerguelen Island.	130	Sand.	(10)
Odontaster, Verrill.				
O. hispidus, Verrill	Off E. coast of N. America.	56–487	.....	(11)
Family *Porcellanasteridæ*, Sladen. Subfamily Porcellanasterinæ, Sladen.				
Porcellanaster, Wyville Thomson.				
**P. cæruleus*, Wyville Thomson	E. of N. America.	(906–1917, Verrill), 1240–1350	Blue mud.	(12)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	+	...	...	...	...	...	...	...	C	A	...	Not yet described.
2)	+	...	...	...	...	...	...	...	...	A	...	Not yet described.
(3)	+	...	...	...	...	...	...	...	C	...	42°·5	.....
(4)	+	...	...	...	...	...	...	...	...	A	...	.....
(5)	+	...	...	...	...	...	...	...	...	A	...	Not yet described.
(6)	+	...	...	...	...	...	...	...	...	A	39°·5	.....
(7)	+	...	...	...	...	...	...	...	...	A	39°·5	.....
(8)	+	...	...	...	...	...	...	...	...	A	...	Not yet described
(9)	+	...	...	...	...	...	...	...	...	A	...	Not yet described.
(10)	...	...	...	+	...	...	...	L	...	...	...	.....
(11)	+	...	...	...	...	...	...	L	C	...	...	.....
(12)	+	...	...	...	...	...	...	...	...	A	37°·2	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA.				
Porcellanasteridæ.				
Porcellanasterinæ.				
Porcellanaster, Wyville Thomson.				
**P. caulifer*, Sladen . . .	Arafura Sea.	800	Green mud.	(1)
**P. crassus*, Sladen . . .	33° 29′ 0″ S., 133° 22′ 0″ W.	2335	Red clay.	(2)
**P. eremicus*, Sladen . .	Between Cape of Good Hope and Tristan da Cunha.	2550	Red clay.	(3)
**P. gracilis*, Sladen . . .	W. of S. America.	2225	Blue mud.	(4)
P. granulosus, Perrier .	Cape Blanco; coast of Sahara; off Arguin.	1268–1749	.....	(5)
P. inermis, Perrier . .	N.E. of San Miguel (Azores); off Arguin.	1637–1749	.....	(6)
**P. tuberosus*, Sladen . . .	South of Japan.	1875	Blue mud.	(7)
P. (?) *pedunculatus*, Perrier .	Off coast of Spain.	1312–1421	.....	(8)
P. (?) *sladeni*, Perrier . .	Off coast of Morocco.	784–1038	.....	(9)
Styracaster, Sladen.				
**S. armatus*, Sladen . . .	Near Caroline Islands.	1850	Globigerina ooze.	(10)
S. edwardsi, Perrier . . .	Off Cape Verde Islands.	1987	.....	(11)
**S. horridus*, Sladen . .	Between Island of Ascension and coast of Africa.	2350	Globigerina ooze.	(12)
S. spinosus, Perrier . . .	N.E. of San Miguel (Azores).	1637	.....	(13)
Hyphalaster, Sladen.				
H. antonii, Perrier . . .	N.E. of San Miguel (Azores).	1637	.....	(14)
**H. diadematus*, Sladen . .	W. of South America.	2160	Blue mud.	(15)
**H. hyalinus*, Sladen . . .	7° 25′ 0″ S., 152° 15′ 0″ W.	2750	Radiolarian ooze.	(16)
**H. inermis*, Sladen . . .	South of Japan.	1875	Blue mud.	(17)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0-150 Fathoms.	Continental, 150-500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	...	...	...	+	...	...	...	...	A	39°·5	.....
(2)	...	...	...	...	...	...	+	...	...	A	34°·8	.....
(3)	...	+	...	...	...	...	...	...	...	A	34°·5	.....
(4)	...	...	...	...	...	...	+	...	...	A	35°·6	.....
(5)	+	...	...	...	...	...	...	...	...	A	...	.....
(6)	+	...	...	...	...	...	...	...	...	A	...	.....
(7)	...	...	...	...	...	+	...	...	...	A	35°·3	.....
(8)	+	...	...	...	...	...	...	...	...	A	...	= *Caulaster pedunculatus*, Perrier.
(9)	+	...	...	...	...	...	...	...	...	A	...	= *Caulaster Sladeni*, Perrier.
(10)	...	...	...	...	...	+	...	...	...	A	35°·4	.....
(11)	+	...	...	...	...	...	...	...	...	A	...	.....
(12)	...	+	...	...	...	...	...	...	...	A	34°·0	.....
(13)	+	...	...	...	...	...	...	...	...	A	...	.....
(14)	+	...	...	...	...	...	...	...	...	A	...	.....
(15)	...	...	...	...	...	...	+	...	...	A	35°·2	.....
(16)	...	...	...	...	...	...	+	...	...	A	35°·1	.....
(17)	...	...	...	...	...	+	...	...	...	A	35°·3	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA.				
Porcellanasteridæ.				
Porcellanasterinæ.				
Hyphalaster, Sladen.				
H. parfaiti, Perrier	Gulf of Gascony.	2617	.....	(1)
**H. planus*, Sladen	53° 55′ 0″ S., 108° 35′ 0″ E.	1950	Diatom ooze.	(2)
Thoracaster, Sladen.				
**T. cylindratus*, Sladen	Between the Canary and Cape Verde Islands.	2400	Globigerina ooze.	(3)
Pseudaster, Perrier.				
P. cordifer, Perrier	N. of Azores.	2219	.....	(4)
Subfamily Ctenodiscinæ, Sladen.				
Ctenodiscus, Müller and Troschel.				
×*C. australis*, Lütken	E. of South America.	55–600	Sand; Green sand.	(5)
C. corniculatus (Linck), Perrier	Scandinavian and N. American coasts; Greenland; Spitzbergen and Nova Zembla; Kara Sea.	7–632	Mud and soft clay, hard occasionally.	(6)
**C. procurator*, Sladen	W. of South America.	40–1325	Blue mud.	(7)
Family *Astropectinidæ*, Gray, *emend.*				
Subfamily Astropectininæ, Sladen.				
Craspidaster, Sladen.				
×*C. hesperus*, Müller and Troschel, sp.	China; Japan; Philippine Islands; Banka Straits; Singapore.	10–20	Mud.	(8)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	+	...	...	...	...	...	...	...	...	A	...	.....
(2)	...	...	...	+	...	...	...	...	...	A	32°·1	.....
(3)	+	...	...	...	...	...	...	...	...	A	36°·6	.....
(4)	+	...	...	...	...	...	...	...	...	A	...	.....
(5)	...	+	...	...	...	...	...	L	C	A	37°·2–47°·8	.....
(6)	+	...	...	...	...	...	...	L	C	A	30°·5–41°·3	= *Astropecten corniculatus*, Linck. Incl.: *Asterias crispata*, Retzius; *Asterias polaris*, Sabine; *Asterias arancia*, Dewhurst; *Astropecten polaris*, Gray; *Ctenodiscus polaris*, Müller and Troschel; *Ctenodiscus pygmæus*, Müller and Troschel; *Ctenodiscus crispatus*, Düben and Koren; *Anodiscus crispatus* (Val.?) Perrier.
(7)	...	...	...	...	...	...	+	L	C	A	36°·0–47°·0	.....
(8)	...	...	...	...	+	+	...	L	...	...	...	= *Archaster hesperus*, Müller and Troschel. Incl.: *Stellaster sulcatus*, Möbius.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA. *Astropectinidæ.* Astropectininæ.				
Leptoptychaster, Smith.				
**L. antarcticus*, Sladen .	Between Marion and Kerguelen Islands.	210	Hard ground (Gravel, shells).	(1)
L. arcticus, Sars, sp. . .	Off North Cape; coast of Norway; E. of N. America.	20–690	Clay, sometimes sandy.	(2)
**L. arcticus*, var. *elongata*, Sladen	E. of N. America.	85–1350	Gravel, stones; Blue mud.	(3)
×*L. kerguelenensis*, Smith . .	Kerguelen Isld.; Marion Isld.	10–100	Volcanic mud.	(4)
Moiraster, Sladen.				
M. magnificus, Bell, sp. . .	St. Helena	?	?	(5)
Astropecten, Linck.				
**A. acanthifer*, Sladen . .	Banda Sea.	140	Blue mud.	(6)
A. alatus, Perrier . . .	?	?	?	(7)
A. alligator, Perrier . . .	Off Florida.	24 (?)	.....	(8)
A. andersoni, Sladen . . .	Mergui Archipelago.	10	.....	(9)
A. antillensis, Lütken . .	St. Thomas; Guadeloupe.	Shallow.	.....	(10)
A. arenarius, Perrier . . .	?	?	?	(11)
A. articulatus, Say . . .	From New Jersey to W. Indies.	Shallow.	.....	(12)
A. aurantiacus (Linné), Gray	Mediterranean; Adriatic; Madeira; Canary Islands.	10–100	.....	(13)
A. bispinosus (Otto), Müller and Troschel	Mediterranean; Adriatic.	2–35	.....	(14)
×*A. brasiliensis*, Müller and Troschel	St. Vincent; Fernando Noronha; Brazil.	7–20	.....	(15)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	...	...	+	...	...	...	...	C	...	...	.....
(2)	+	...	...	...	...	...	...	L	C	A	30°·0–41°·3	= *Astropecten arcticus*, Sars; *Archaster arcticus*, Perrier. Incl.: *Astropecten Lütkeni*, Barrett.
(3)	+	...	...	...	...	...	...	L	C	A	35°·0–37°·2	.....
(4)	...	...	...	+	...	...	...	L	...	...	...	= *Leptychaster kerguelenensis*, Smith (*olim*). Incl.: *Archaster excavatus*, Wyville Thomson.
(5)	...	+	...	...	...	...	...	?	...	...	...	= *Archaster magnificus*, Bell.
(6)	...	...	...	...	+	...	...	L	...	...	...	.....
(7)	...	...	...	...	...	...	...	?	...	...	...	.....
(8)	+	...	...	...	...	...	...	L	...	...	...	.....
(9)	...	...	+	...	...	...	...	L	...	...	...	.....
(10)	+	...	...	...	...	...	...	L	...	...	...	.....
(11)	...	...	...	...	...	...	...	?	...	...	...	.....
(12)	+	...	...	...	...	...	...	L	...	...	...	Incl.: *Astropecten dubius*, Gray; *Astropecten aranciaca*, Gould.
(13)	+	...	...	...	...	...	...	L	...	...	...	= (?) *Astropecten echinatus major*, Linck; (?) *Astropecten stellatus*, Linck; *Asterias aranciaca*, Linné; *Stellaria aurantiaca*, Nardo. Incl.: *Astropecten crenaster*, Dujardin and Hupé; *Astropecten perarmatus*, Perrier; *Astropecten meridionalis*, Studer; *Astropecten antarcticus*, Studer.
(14)	+	...	...	...	...	...	...	L	...	...	...	= (?) *Astropecten echinatus minor*, Linck; *Asterias bispinosa*, Otto; *Stellaria bispinosa*, Nardo. Incl.: *Astropecten myosurus*, Perrier.
(15)	+	+	...	...	...	...	...	L	...	...	...	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA. *Astropectinidæ.* Astropectininæ.				
Astropecten, Linck.				
**A. brevispinus*, Sladen	South of Japan.	345	Green mud.	(1)
A. buschii, Müller and Troschel	?	?	?	(2)
A. calcitrapa, Lamarck	?	?	?	(3)
A. capensis, Studer	Table Bay (Cape of Good Hope).	50	Hard ground (rolled pebbles, &c.).	(4)
A. ciliatus, Grube	Puerto Cabello.	...	.....	(5)
**A. cingulatus*, Sladen	S.E. of Pernambuco.	32–400	Red mud.	(6)
A. duplicatus, Gray	Florida; Vera Cruz; St. Vincent; Brazil (*fide* Perrier).	...	.....	(7)
A. dussumieri, Perrier	?	?	?	(8)
A. edwardsi, Verrill	Off Auckland (New Zealand).	...	.....	(9)
A. erinaceus, Gray	California; Realejo; Panama; Guayaquil.	?	?	(10)
A. formosus, Sladen	Corea; W. of Niphon.	36–60	.....	(11)
A. fragilis, Verrill	Panama; Zorritos (Peru).	Shallow.	Sand.	(12)
×*A. granulatus*, Müller and Troschel	Arafura Sea.	28	Green mud.	(13)
A. hemprichii, Müller and Troschel	Red Sea; Mauritius; Madras; Mergui.	...	.....	(14)
**A. hermatophilus*, Sladen	Off the Azores.	450	Volcanic mud.	(15)
A. hispidus, Müller and Troschel	?	?	?	(16)
**A. imbellis*, Sladen	Off the Philippine Islands.	100	Green mud.	(17)
A. indicus, Döderlein	Ceylon.	...	.....	(18)
A. irregularis, Linck.	Coasts of Scandinavia and Britain; Mediterranean (*fide* Marion); off Liberia (*fide* Studer).	10–374	.....	(19)
×*A. japonicus*, Müller and Troschel	Off Japan.	5–50	Sand; Blue mud.	(20)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	...	.....	...	...	+	....	...	C	...	41°·1	.....
(2)	...	...	.....	...	...	...	...	?	...	...	...	.....
(3)	...	...	....	...	...	...	....	?	...	...	...	.....
(4)	...	+	.....	...	...	...	....	L	...	...	...	.....
(5)	+	...	...	...	...	...	...	L	...	...	...	.....
(6)	...	+	...	...	...	...	...	L	C	...	...	.....
(7)	+	+	...	...	...	...	...	L	...	...	...	Incl.: *Astropecten Valenciennii*, Müller and Troschel; *Astropecten variabilis*, Lütken.
(8)	...	...	...	...	...	...	...	?	...	...	...	.....
(9)	...	...	...	...	...	...	+	L	...	...	...	.....
(10)	...	...	...	...	...	+	+	L	...	...	...	Incl.: *Astropecten armatus*, Gray; *Astropecten Örstedii*, Lütken.
(11)	...	...	....	...	...	+	...	L	...	...	...	.....
(12)	...	...	.....	...	...	+	..+	L	...	...	...	.....
(13)	...	...	...	...	+	...	...	L	...	...	...	.....
(14)	...	...	+	...	...	...	...	L	...	...	...	.....
(15)	+	...	.....	...	...	...	...	...	C	...	...	.....
6)	...	...	...	...	...	...	...	?	...	...	...	.....
(17)	...	...	...	...	+	...	...	L	...	...	...	.....
(18)	...	...	+	...	...	...	...	L	...	...	...	.....
(19)	+	...	...	...	...	...	...	L	C	...	44°·0–49°·4	Incl.: *Asterias aranciaca*, O. F. Müller; *Astropecten Mülleri*, Müller and Troschel; *Astropecten echinulatus*, Müller and Troschel; *Astropecten acicularis*, Norman.
(20)	...	...	...	...	...	+	...	L	...	...	...	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-bottom.	
PHANEROZONIA. *Astropectinidæ.* Astropectininæ. *Astropecten*, Linck.				
A. javanicus, Lütken. . .	Off Java.	...	.....	(1)
A. jonstoni, Delle Chiaje . .	Mediterranean; Föhr Isld.(?)	20–35	.....	(2)
A. longispinus, Müller and Troschel	Off Java.	...	.....	(3)
A. mauritianus, Gray . .	Mauritius.	...	.....	(4)
**A. mesactus*, Sladen . .	Off Tristan da Cunha; E. of Uruguay (*fide* Studer).	44–90	.....	(5)
**A. monacanthus*, Sladen . .	Off the Philippine Islands.	20	Mud.	(6)
A. notograptus, Sladen . .	Mergui Archipelago.	...	.....	(7)
**A. pectinatus*, Sladen .	S.E. of Australia; Port Phillip (*fide* Bell).	6–40	Sand and shells.	(8)
A. pentacanthus (Delle Chiaje), Müller and Troschel .	Mediterranean; Adriatic; Cape Verde Islands (*fide* Studer).	5–115	.....	(9)
A. peruvianus, Verrill . .	Payta (Peru).	...	.....	(10)
A. petalodea, Retzius, sp. . .	Nicobar Islands.	...	.....	(11)
A. platyacanthus (Philippi), Müller and Troschel .	Mediterranean; Adriatic; Azores (*fide* Barrois).	2–35	.....	(12)
×*A. polyacanthus*, Müller and Troschel . . .	Red Sea; Mauritius; Ceylon; Andaman Islands; Port Jackson; Australia; New Zealand; China; Japan; Admiralty and Fiji Islands.	2–50	.....	(13)
**A. pontoporæus*, Sladen . .	Off the Cape of Good Hope.	5–20	.....	(14)
A. preissii, Müller and Troschel.	W. and S.W. of Australia.	...	.....	(15)
A. regalis, Gray. . .	San Blas, San Salvador, Gulf of Nicoya.	...	.....	(16)
A. richardi (Val.), Perrier. .	Off French Guiana.	...	.....	(17)
A. samoensis, Perrier. . .	Samoa.	...	.....	(18)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	...	...	...	+	...	...	L	...	...	...	.....
(2)	+	...	...	...	...	...	...	L	...	...	...	= *Asterias Jonstoni*, Delle Chiaje. Incl.: *Astropecten squamatus*, Müller and Troschel; *Astropecten aster*, Filippi.
(3)	...	...	...	...	+	...	...	L	...	...	...	.....
(4)	...	...	+	...	...	...	...	L	...	...	...	.....
(5)	...	+	...	...	...	...	...	L	...	...	...	.....
(6)	...	...	...	...	+	...	...	L	...	...	...	.....
(7)	...	...	+	...	...	...	...	L	...	...	...	.....
(8)	...	...	...	...	...	...	+	L	...	...	...	.....
(9)	+	...	...	...	...	...	...	L	...	...	...	= *Asterias pentacantha*, Delle Chiaje.
(10)	...	...	...	...	...	...	+	?	...	...	...	.....
(11)	...	...	+	...	...	...	...	L	...	...	...	= *Asterias petalodea*, Retzius. Incl.: *Astropecten euryacanthus*, Lütken.
(12)	+	...	...	...	...	...	...	L	...	...	...	= *Asterias platyacantha*, Philippi.
(13)	...	...	+	...	...	+	+	L	...	...	...	Incl.: *Astropecten hystrix*, Müller and Troschel; *Astropecten armatus*, Müller and Troschel; *Astropecten vappa*, Müller and Troschel; *Astropecten chinensis*, Grube; *Astropecten ensifer*, Grube.
(14)	...	+	...	...	...	...	...	L	...	...	...	.....
(15)	...	...	+	...	...	...	...	?	...	...	...	.....
(16)	...	...	...	...	...	+	...	L	...	...	...	Incl.: *Astropecten cœlacanthus*, v. Martens; *Astropecten paleatus*, Grube; *Astropecten marginatus*, Müller and Troschel; (?) *Astropecten spatuliger*, Perrier.
(17)	+	...	...	...	...	...	...	L	...	...	...	.....
(18)	...	...	...	...	...	...	+	L	...	...	...	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA.				
Astropectinidæ.				
Astropectininæ.				
Astropecten, Linck.				
A. schoenleinii, Müller and Troschel	Off W. coast of Africa.	...	.....	(1)
A. scoparius (Val.), Müller and Troschel . . .	Japan (*fide* Perrier).	...	.....	(2)
A. serratus, Müller and Troschel	Bay of Biscay; Mediterranean.	...	.....	(3)
A. spinulosus (Philippi), Müller and Troschel . . .	Mediterranean; Adriatic.	10–30	.....	(4)
A. tamilicus, Döderlein.	Ceylon.	...	.....	(5)
A. tiedemanni, Müller and Troschel	?	?	?	(6)
A. triseriatus, Müller and Troschel	Off S.W. Australia.	...	.....	(7)
×*A. velitaris*, von Martens .	China Sea; Amboina; N.W. Australia; Admiralty Islds.	15–25	.....	(8)
A. vestita (Say), Perrier . .	E. of North America.	...	.....	(9)
**A. zebra*, Sladen . . .	Torres Strait.	8	Coral mud.	(10)
**A. zebra*, var. *rosea*, Sladen .	Torres Strait.	6	Coral mud.	(11)
Psilaster, Sladen.				
**P. acuminatus*, Sladen .	Simon's Bay (Cape of Good Hope); E. of Australia; W. of New Zealand.	Shallow to 950	Green mud; Blue mud.	(12)
P. andromeda, Müller and Troschel, sp. . . .	Scandinavian and British coasts; Bay of Biscay.	40–690	Clay, sometimes sandy.	(13)
**P. cassiope*, Sladen . . .	Off the Cape Verde Islands.	...	.....	(14)
**P. gracilis*, Sladen . . .	S. of Japan.	1875	Blue mud.	(15)
**P. patagiatus*, Sladen . .	Off the Cape Verde Islands.	...	.....	(16)
Phoxaster, Sladen.				
**P. pumilus*, Sladen . . .	E. of North America.	1240–1700	Blue mud.	(17)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	+	...	...	...	...	...	...	L	...	...	...	.....
(2)	...	...	...	...	...	+	...	L	...	...	...	Incl.: (?) *Astropecten umbrinus*, Grube.
(3)	+	...	...	...	...	...	...	L	...	...	...	Incl.: *Astropecten aranciacus*, P. Fischer.
(4)	+	...	...	...	...	...	...	L	...	...	...	= *Asterias spinulosa*, Philippi. Incl.: *Astropecten archimedis* (Val.), Perrier.
(5)	...	...	+	...	...	...	...	L	...	...	...	.....
(6)	...	...	...	...	...	...	...	?	...	...	...	.....
(7)	...	...	+	...	...	...	...	L	...	...	...	.....
(8)	...	...	+	...	+	+	+	L	...	...	...	.....
(9)	+	...	...	...	...	...	...	L	...	...	...	.....
(10)	...	...	...	...	+	...	...	L	...	...	...	Probably incl.: *Astropecten coppingeri*, Bell.
(11)	...	...	...	...	+	...	...	L	...	...	...	.....
(12)	...	+	...	...	...	...	+	L	C	A	36°·5	= (?) *Archaster Christii*, Studer (*von* Düben and Koren).
(13)	+	..	...	...	...	...	...	L	C	A	30°·0	= *Asterias aranciata* (var.), Parelius; *Astropecten andromeda*, Müller and Troschel; *Archaster andromeda*, Möbius and Bütschli. Incl.: *Astropecten christi*, Düben and Koren; *Archaster christi*, Perrier; *Goniopecten chisti* (err. typ.), Perrier.
(14)	+	...	...	...	...	...	...	?	...	...	...	.....
(15)	...	...	...	...	...	+	...	...	...	A	35°·3	.....
(16)	+	...	...	...	...	...	...	?	...	...	...	.....
(17)	+	...	...	...	...	...	...	...	...	A	36°·2–37°·2	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA.				
Astropectinidæ.				
Astropectininæ.				
Bathybiaster, Danielssen and Koren.				
**B. loripes*, Sladen . . .	W. of South America.	245	Blue mud.	(1)
**B. loripes*, var. *obesa*, Sladen	Off Kerguelen and Heard Island.	75–127	Volcanic mud.	(2)
B. pallidus, Danielssen and Koren	Off Norway and Spitzbergen.	412–1215	Clay.	(3)
B. vexillifer, Wyville Thomson, sp.	Faeröe Channel.	344	.....	(4)
Ilyaster, Danielssen and Koren.				
I. mirabilis, Danielssen and Koren	Off the coast of Norway.	498	Clay.	(5)
Subfamily Luidiinæ, Sladen.				
Luidia, Forbes.				
**L. africana*, Sladen . .	Simon's Bay (Cape of Good Hope); coast of Morocco.	Shallow to 128	.....	(6)
×*L. alternata* (Say), Lütken	E. of North America; Florida; Tortugas; St. Thomas, Bahia.	71–88	Volcanic sand.	(7)
**L. aspera*, Sladen . .	Off Philippine Islands; N. of New Guinea.	10–150	Green mud; Coral mud.	(8)
L. barbadensis, Perrier . .	Barbados.	40–209	Calcareous pebbles; fine mud.	(9)
L. bellonæ, Lütken . . .	Panama; Guayaquil; Callao.	...	.....	(10)
L. brevispina, Lütken . .	Sandwich Islands; Mazatlan.	...	.....	(11)
L. californica, Perrier . .	California.	...	.....	(12)
L. chefuensis, Grube . . .	Singapore.	...	.....	(13)
L. ciliaris (Philippi), Gray	Faeröe Channel; British Islands; Cattegat; coast of France; Mediterranean; Cape Verde Islands (*fide* Studer).	Littoral to 87	.....	(14)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	...	...	...	...	...	+	...	C	...	46°·0	.....
(2)	...	...	...	+	...	...	...	L	...	...	...	.....
(3)	+	...	...	...	...	...	...	...	C	A	...	=*Astropecten pallidus*, Danielssen and Koren.
(4)	+	...	...	...	...	...	...	...	C	...	30°·0	=*Archaster vexillifer*, Wyville Thomson.
(5)	+	...	...	...	...	...	...	...	C	...	30°·0	.....
(6)	+	+	...	...	...	...	...	L	...	...	55°·2	.....
(7)	+	+	...	...	...	...	...	L	...	...	69°·0	=*Asterias alternata*, Say. Incl.: *Luidia granulosa* (Val.), Perrier.
(8)	...	...	...	...	+	...	+	L	...	...	...	.....
(9)	+	...	...	...	...	...	...	L	C	...	49°·75–60·0	.....
(10)	...	...	...	...	...	+	+	L	...	...	...	.....
(11)	...	...	...	...	...	+	...	L	...	...	...	.....
(12)	...	...	...	...	...	+	...	...	...	...	...	.....
(13)	...	...	...	...	+	...	...	L	...	...	...	.....
(14)	+	...	...	...	...	...	...	L	...	...	...	=*Asterias ciliaris*, Philippi; *Asterias rubens*, Johnston. Incl.: *Luidia fragilissima* (*pars*), Forbes; *Asterias pectinata*, Couch; *Asterias Imperati*, Delle Chiaje; *Luidia Savignyi* (*pars*), Müller and Troschel.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA. *Astropectinidæ.* Luidiinæ.				
Luidia, Forbes.				
×*L. clathrata* (Say), Lütken	Carolina; Florida; Hayti; Martinique; St. Thomas; Bahia; Rio Janeiro.	7–25	.....	(1)
L. columbiæ (Gray), Perrier	San Blas; Acajutla; Realejo; Puntas Arenas; Panama.	...	.....	(2)
L. convexiuscula, Perrier .	Barbados; Montserrat; Grenada; St. Kitts.	56–208	Volcanic sand; madrepore sand; broken shells; hard ground.	(3)
L. elegans, Perrier . . .	Strait of Florida; Barbados.	17 (?)–200	Calcareous pebbles.	(4)
L. foliata, Grube . . .	California.	...	.....	(5)
**L. forficifer*, Sladen . .	Torres Strait; Arafura Sea; Mergui.	6–28	Coral mud; Green mud.	(6)
L. hardwickii (Gray), Perrier	Indian Ocean; Madras (*fide* Bell).	...	.....	(7)
**L. limbata*, Sladen . . .	Yokohama (Japan).	5–25	.....	(8)
**L. longispina*, Sladen . .	Off the Philippine Islands.	20	Mud.	(9)
L. maculata, Müller and Troschel	Mozambique; Coromandel; Ceylon; Madras; Mergui; Java; Manilla; Japan.	...	.....	(10)
L. quinaria (von Martens), Sladen	Off Japan.	...	.....	(11)
L sarsii, Düben and Koren	Coast of Norway; British Islands; Cape Verde Islands (*fide* Studer).	Littoral to 374	Sand; coarse shell-sand.	(12)
L. savignyi (Audouin), Gray	Red Sea; Mauritius; E. coast of Africa.	...	.....	(13)
L. senegalensis (Lamarck), Müller and Troschel . . .	Senegal; Guadeloupe; Jamaica; Brazil; Cotinquiba.	...	.....	(14)
L. variegata, Perrier . .	Breton Island (mouth of Mississippi).	...	.....	(15)
Platasterias, Gray.				
P. latiradiata, Gray . . .	Tehuantepec (Mexico).	...	.....	(16)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	+	+	...	...	...	....	...	L	...	...	...	= *Asterias clathrata*, Say. Incl.: *Luidia gemmacea* (Val. M.S.).
(2)	...	...	...	...	...	+	...	L	...	...	...	= *Petalaster columbiæ*, Gray. Incl.: *Luidia tessellata*, Lütken.
(3)	+	...	...	...	...	...	...	L	C	...	55°·25–74°·75	.....
(4)	+	...	...	...	...	...	...	L	C	...	49°·75	.....
(5)	...	...	...	...	...	+	...	L	...	...	...	.....
(6)	...	...	+	...	+	...	...	L	...	...	...	.....
(7)	...	...	+	...	...	...	...	L	...	...	...	= *Petalaster Hardwickii*, Gray.
(8)	...	...	...	...	...	+	...	L	...	...	...	.....
(9)	...	...	...	...	+	...	...	L	...	...	...	.....
(10)	...	...	+	...	+	+	...	L	...	...	...	.....
(11)	...	...	...	...	...	+	...	?	...	...	...	= *Luidia maculata*, var. *quinaria*, von Martens.
(12)	+	...	...	...	...	...	...	L	C	...	44°·0–49°·1	Incl.: *Luidia fragilissima* (*pars*), Forbes; *Luydia Savignyi* (*pars*), Düben and Koren.
(13)	...	...	+	...	...	...	...	L	...	...	...	= *Asterias Savignyi*, Audouin.
(14)	+	+	...	...	...	...	...	?	...	...	...	= *Asterias senegalensis*, Lamarck. Incl.: *Luidia Maregravii*, Steenstrup.
(15)	+	...	...	...	...	...	...	?	...	...	...	.....
(16)	...	...	...	...	...	+	...	?	...	...	...	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA. Family *Pentagonasteridæ*, Perrier. Subfamily Pentagonasterinæ, Sladen.				
Pentagonaster, Linck.				
P. affinis, Perrier	Dominique; off Havana.	1131–1323	Fine mud and sand.	(1)
**P. arcuatus*, Sladen	South of Japan.	345	Green mud.	(2)
×*P. astrologorum* (Müller and Troschel), Perrier	Sydney, Australia.	...	.....	(3)
P. auratus (Gray), Perrier	Australia.	...	.....	(4)
P. australis (Gray), Perrier	W. and S. Australia; Tasmania.	...	.....	(5)
P. belli, Studer	Puntas Arenas (Magellan Strait).	...	.....	(6)
P. coppingeri, Bell	Port Curtis (Queensland); Prince of Wales Channel.	3–11	.....	(7)
P. crassus, Perrier	Off Morocco.	1139	.....	(8)
P. dentatus, Perrier	Grenada; Morro-Light; Hayti.	41–1500	Globigerina mud.	(9)
P. deplasi, Perrier	Morocco; Pilones.	577–784	.....	(10)
P. fallax, Perrier	S. of Fayal (Azores).	687	.....	(11)
P. fonki (Philippi), Perrier	Puerto Montt (Chili).	...	.....	(12)
P. gibbosus, Perrier	?	?	?	(13)
P. gosselini, Perrier	Morocco; Canaries; Azores.	517–869	.....	(14)
P. grandis, Gray, sp.	W. Australia; Port Phillip (*fide* Bell).	...	.....	(15)
×*P. granularis*, Retzius, sp.	Coasts of Scandinavia; Britain and United States.	20–640	Sand, shells, clay, gravel, stones.	(16)
P. grenadensis, Perrier	Off Grenada.	176 or 576	.....	(17)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	+	...	...	...	...	...	...	...	...	A	39°·5	.....
(2)	...	...	...	...	...	+	...	...	C	...	41°·1	.....
(3)	...	...	...	...	...	...	+	L	...	...	...	=*Astrogonium astrologorum*, Müller and Troschel; *Pentagonaster* (*Tosia*) *astrologorum*, Perrier.
(4)	...	...	...	...	...	...	+	L	...	...	...	=*Tosia aurata*, Gray; *Pentagonaster* (*Tosia*) *auratus*, Perrier. Incl.: *Astrogonium australe*, Müller and Troschel. *Astrogonium Emilii*, Perrier.
(5)	...	...	+	...	...	...	+	L	...	...	...	=*Asterias procyon*, Valenciennes; *Tosia australis*, Gray; *Pentagonaster* (*Tosia*) *australis*, Perrier. Incl.: *Astrogonium geometricum* (Val.), Müller and Troschel.
(6)	...	...	...	...	...	...	+	L	...	...	...	.....
(7)	...	...	...	...	+	...	+	L	...	...	...	.....
(8)	+	...	...	...	...	...	...	...	...	A	...	.....
(9)	+	...	...	...	...	...	...	L	C	A	39°·5–41°·5	.....
(10)	+	...	...	...	...	...	...	...	...	A	...	.....
(11)	+	...	...	...	...	...	...	...	...	A	...	=*Astrogonium fallax*, Perrier.
(12)	...	...	...	...	...	...	+	L	...	...	...	=*Astrogonium Fonki*, Philippi.
(13)	...	...	...	...	...	...	...	?	...	...	...	.....
(14)	+	...	...	...	...	...	...	...	...	A	...	.....
(15)	...	...	+	...	...	...	+	L	...	...	...	=*Tosia grandis*, Gray; *Pentagonaster* (*Tosia*) *grandis*, Perrier.
(16)	+	...	...	...	...	...	...	L	C	A	35°·0	=*Asterias tessellata* (*pars*), Lamarck; *Astrogonium granulare*, Müller and Troschel; *Gonionaster granularis*, Lütken; *Pentagonaster* (*Astrogonium*) *granularis*, Perrier. Incl.: *Astrogonium boreale*, Barrett; *Pentagonaster* (*Astrogonium*) *borealis*, Perrier.
(17)	+	...	...	...	...	...	...	...	C	?	39°·75	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA.				
Pentagonasteridæ.				
Pentagonasterinæ.				
Pentagonaster, Linck.				
P. hæsitans, Perrier . . .	Off Cape Ghir.	1208	.....	(1)
P. inæqualis, Gray, sp. .	Endeavour River (N.E. Australia); (?) New Guinea or (?) Amboina (Gray).	?	?	(2)
P. intermedius, Perrier . .	Off Havana.	930	.....	(3)
**P. japonicus*, Sladen . . .	South of Japan.	345	Green mud.	(4)
P. lamarcki (Müller and Troschel), Perrier . .	?	?	?	(5)
**P. lepidus*, Sladen . . .	Azores.	1000	Volcanic mud.	(6)
P. magnificus, Müller and Troschel, sp. . . .	Tasmania; Bass Strait.	...	.....	(7)
P. mammillatus (Val.), Perrier .	?	?	?	(8)
P. minimus, Perrier . . .	?	?	?	(9)
P. mirabilis, Perrier . . .	Smyrna (Mediterranean).	...	.....	(10)
P. nobilis, Müller and Troschel, sp.	S.W. Australia; New South Wales.	...	.....	(11)
P. ornatus, Müller and Troschel, sp.	Port Stephens or Moreton Bay (?) (*fide* T. Woods).	...	.....	(12)
P. parvus, Perrier . .	Barbados; Grenada; Gulf of Mexico.	25–125	Broken shells and corals; Hard ground	(13)
**P. patagonicus*, Sladen .	Off Strait of Magellan (Atlantic side), and off Smyth Channel.	55–245	Sand; Blue mud.	(14)
P. perrieri, Sladen . . .	Morocco; Sahara; Azores.	453–787	.....	(15)
P. placenta, Müller and Troschel	Mediterranean; Adriatic.	40–50	.....	(16)
P. ruber, Gray, sp. . .	Australia (? South Coast, *fide* T. Woods).	...	.....	(17)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	+	...	...	...	...	...	...	...	...	A	...	.....
(2)	...	...	...	...	?	...	+	?	...	...	...	= *Astrogonium inæquale*, Gray; *Pentagonaster* (*Astrogonium*) *inæqualis*, Perrier.
(3)	+	...	...	...	...	...	...	...	...	A	39°·5	.....
(4)	...	...	...	...	...	+	...	...	C	...	41°·1	.....
(5)	...	...	...	...	...	...	...	?	...	...	...	= *Astrogonium Lamarckii*, Müller and Troschel.
(6)	+	...	...	...	...	...	...	...	...	A	...	.....
(7)	...	...	...	...	...	...	+	?	...	...	...	= *Pentagonaster* (*Tosia*) *magnificus*, Perrier.
(8)	...	...	...	...	...	...	...	?	...	...	...	= *Goniodiscus mammillatus* (Val.), Müller and Troschel; *Hosea* (?) *mammillatus*, Gray; *Pentagonaster* (*Astrogonium*) *mammillatus*, Perrier.
(9)	...	...	...	...	...	...	...	?	...	...	...	.....
(10)	+	...	...	...	...	...	...	L	...	...	...	= *Pentagonaster* (*Astrogonium*) *mirabilis*, Perrier.
(11)	...	...	+	...	...	...	+	L	...	...	...	= *Pentagonaster* (*Tosia*) *nobilis*, Perrier.
(12)	...	...	...	...	...	...	+	L	...	...	...	= *Pentagonaster* (*Tosia*) *ornatus*, Perrier.
(13)	+	...	...	...	...	...	...	L	...	...	58°·5–61°·5	.....
(14)	...	+	...	...	...	...	+	L	C	...	46°·0–47°·8	.....
(15)	+	...	...	...	...	...	...	...	C	A	...	= *Pentagonaster grandis*, Perrier (*non* Gray).
(16)	+	...	...	...	...	...	...	L	...	...	...	Incl.: *Goniodiscus placentæformis*, Heller; *Goniodiscus acutus*, Heller; *Hosea* (?) *placenta*, Gray; *Pentagonaster* (*Astrogonium*) *placenta*, Perrier; *Pentagonaster* (*Astrogonium*) *acutus*, Perrier; perhaps also *Pentagonaster mirabilis*, Perrier.
(17)	...	...	...	...	...	...	+	L	...	...	...	= *Tosia rubra*, Gray; *Pentagonaster* (*Tosia*) *ruber*, Perrier.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA. *Pentagonasteridæ.* Pentagonasterinæ.				
Pentagonaster, Linck.				
×*P. semilunatus*, Linck .	Senegal; Cape Verde Islands; S. Carolina; Brazil; Zanzibar; Celebes; China.	...	.....	(1)
P. tuberculatus, Gray, sp. . .	Swan River; Champion River.	...	.....	(2)
P. tuberculatus (Gray), Perrier .	Port Natal; Cape of Good Hope.	117	.....	(3)
P. validus, Bell . . .	Thursday Island (Torres Strait).	3–5	Sand.	(4)
P. vincenti, Perrier . . .	Canary Islands.	517	.....	(5)
P. (?) *alexandri*, Perrier . .	Havana and West Indian area.	84–242 and (?) 1930	.....	(6)
P. (?) *elongatus*, Perrier . .	N.E. of Azores.	1637	.....	(7)
Astrogonium, Müller and Troschel, *emend.*				
A. abnormale, Gray, sp. . .	?	?	?	(8)
A. bourgeti, Perrier, sp. .	St. Vincent; Cape Verde Islands.	189–317	.....	(9)
A. dübeni, Gray, sp. . . .	W. and S. Australia.	...	.....	(10)
A. gunnii, Perrier, sp. .	George Town, Tasmania; coast of Victoria.	...	.....	(11)
A. pulchellum (Gray), Müller and Troschel . . .	China (*fide* Gray); New South Wales; Tasmania; New Zealand; East Indies (Möbius).	...	.....	(12)
Calliaster, Gray.				
**C. baccatus*, Sladen . .	Simon's Bay (Cape of Good Hope).	5–18	.....	(13)
C. childreni, Gray . . .	Japan.	...	.....	(14)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	+	+	+	...	+	+	...	L	...	...	...	= *Asterias granularis* (*pars*), Gmelin; *Asterias tessellata* (*pars*), Lamarck; *Goniaster cuspidatus*, Gray; *Astrogonium cuspidatum*, Müller and Troschel; *Goniaster semilunatus*, von Martens; *Astrogonium semilunatum*, Perrier. Incl.: *Astrogonium dubium*, Perrier; *Goniaster americanus*, Verrill; *Goniaster africanus*, Verrill.
(2)	...	...	+	...	...	...	...	L	...	...	...	= *Tosia tubercularis*, Gray; *Pentagonaster* (*Tosia*) *tubercularis*, Perrier.
(3)	...	...	+	...	...	...	...	L	...	...	...	= *Astrogonium tuberculatum*, Gray; *Pentagonaster* (*Astrogonium*) *tuberculatus*, Perrier.
(4)	...	...	...	...	+	...	...	L	...	...	...	.....
(5)	+	...	...	...	...	...	...	...	...	A	...	.....
(6)	+	...	...	...	...	...	...	L	C	?	39°·5–60°·0	Should probably be referred to *Nymphaster*.
(7)	+	...	...	...	...	...	...	...	...	A	...	Should probably be referred to *Paragonaster*.
(8)	...	...	...	...	...	...	...	?	...	...	...	= *Pentagonaster abnormalis*, Gray.
(9)	+	...	...	...	...	...	...	...	C	...	...	= *Stephanaster Bourgeti*, Perrier.
(10)	...	...	+	...	...	...	...	L	...	...	...	= *Pentagonaster Dübeni*, Gray; *Goniaster Dübeni*, Lütken; *Pentagonaster* (*Dorigona*) *Dübeni*, T. Woods.
(11)	...	...	+	...	...	...	...	L	...	...	...	= *Pentagonaster Gunnii*, Perrier; *Pentagonaster* (*Dorigona*) *Gunnii*, T. Woods.
(12)	...	...	...	...	?	?	+	L	...	...	...	= *Asterias pulchella*, Gray; *Pentagonaster pulchellus*, Gray; *Pentagonaster* (*Dorigona*) *pulchellus*, T. Woods. Incl.: *Stephanaster elegans*, Ayres; *Astrogonium crassimanum*, Möbius.
(13)	...	+	...	...	...	+	...	...	...	...	...	.....
(14)	...	...	...	...	...	...	...	...	...	...	...	= *Pentagonaster* (*Calliaster*) *Childreni*, Perrier.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA.				
Pentagonasteridæ.				
Pentagonasterinæ.				
Chitonaster, Sladen.				
**C. cataphractus*, Sladen . .	62° 26′ 0″ S., 95° 44′ 0″ E.	1975	Diatom ooze.	(1)
Calliderma, Gray.				
C. emma, Gray	Japan (?).	?	?	(2)
Iconaster, Sladen.				
I. longimanus, Möbius, sp. .	Malacca (?); Percy Island (Queensland); Prince of Wales Channel (*fide* Bell).	7	?	(3)
Gnathaster, Sladen.				
G. dilatatus, Perrier, sp. . .	New Zealand.	...	.....	(4)
**G. elongatus*, Sladen . .	Off Marion Island; Kerguelen Island; Heard Island.	50–150	Volcanic mud; coarse gravel.	(5)
G. grayi, Bell, sp. . .	Sandy Point (Strait of Magellan).	9–10	Sand.	(6)
×*G. meridionalis*, Smith, sp.	Off Marion Island; Kerguelen Island; Heard Island.	5–150	Volcanic mud; coarse gravel.	(7)
G. miliaris, Gray, sp. . .	New Zealand.	...	.....	(8)
G. paxillosus, Gray, sp. .	N. Australia; Sandy Point (Strait of Magellan).	9–10	Sand.	(9)
**G. pilulatus*, Sladen . .	Cape Virgins, off Strait of Magellan.	55	Sand.	(10)
G. singularis, Müller and Troschel, sp.	W. of South America; Tom Bay (*fide* Bell).	Shallow to 30	Rock; kelp; mud	(11)
G. (?) *verrucosus*, Philippi, sp. .	Near Valparaiso.	...	.....	(12)
Nymphaster, Sladen.				
**N. albidus*, Sladen . . .	Off Cape Verde Islands.	.	.....	(13)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	...	...	+	...	...	...	...	...	A	31°·2	.....
(2)	...	...	...	...	...	?	...	?	...	...	...	= *Pentagonaster* (*Calliderma*) *Emma*, Perrier.
(3)	...	...	...	...	+	...	+	L	...	...	...	= *Astrogonium longimanum*, Möbius; *Goniaster longimanus*, Lütken; *Dorigona longimana*, Gray; *Pentagonaster* (*Dorigona*) *longimanus*, Perrier. Incl.: *Astrogonium Souleyeti*, Dujardin and Hupé; *Archaster lucifer*, Valenciennes.
(4)	...	...	...	...	...	...	+	L	...	...	...	= *Pentagonaster* (*Astrogonium*) *dilatatus*, Perrier.
(5)	...	...	...	+	...	...	...	L	...	...	35°·2	.....
(6)	...	+	...	...	...	...	...	L	...	...	...	= *Calliderma grayi*, Bell.
(7)	...	...	...	+	...	...	...	L	...	...	35°·2	= *Astrogonium meridionale*, Smith; *Pentagonaster meridionalis*, Smith.
(8)	...	...	...	...	...	...	+	L	...	...	...	= *Astrogonium miliare*, Gray; *Pentagonaster* (*Astrogonium*) *miliaris*, Perrier.
(9)	...	+	...	...	+	...	...	L	...	...	...	= *Astrogonium paxillosum*, Gray; *Pentagonaster* (*Astrogonium*) *paxillosus*, Perrier.
(10)	...	+	...	...	...	...	...	L	...	...	47°·8	.....
(11)	...	...	...	...	...	...	+	L	...	...	...	= *Goniodiscus singularis*, Müller and Troschel; *Pentagonaster* (*Astrogonium*) *singularis*, Perrier.
(12)	...	...	...	...	...	...	+	L	...	...	...	= *Goniodiscus verrucosus*, Philippi; *Pentagonaster* (*Astrogonium*) *verrucosus*, Perrier.
(13)	+	...	...	...	...	...	...	...	...	?	...	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA. *Pentagonasteridæ.* Pentagonasterinæ.				
Nymphaster, Sladen.				
**N. basilicus*, Sladen	E. coast of Brazil.	1200	Red mud.	(1)
**N. bipunctus*, Sladen	N. of Admiralty Island.	150	Coral mud.	(2)
**N. protentus*, Sladen	S.W. of Canary Islands.	1525	Hard ground.	(3)
**N. symbolicus*, Sladen	Off Philippine Islands; Arafura Sea.	28–115	Green mud.	(4)
**N. symbolicus*, var. *breviradiata*, Sladen	Banda Sea.	140	Blue mud.	(5)
N. (?) *arenatus*, Perrier, sp.	Off Grenada; Guadeloupe; Barbados; Havana; Morocco.	164–893	Fine mud and sand.	(6)
N. (?) *mœbii*, Studer, sp.	N.W. Australia.	195	Grey mud.	(7)
N. (?) *prehensilis*, Perrier, sp.	Off Morocco; Cape Spartel.	295–566	.....	(8)
N. (?) *subspinosus*, Perrier, sp.	Off Havana; Barbados; Carriacou.	163–209	Fine sand and clay.	(9)
N. (?) *ternalis*, Perrier, sp.	Off Guadeloupe and Grenada.	416–734	Greyish brown mud.	(10)
Paragonaster, Sladen.				
**P. ctenipes*, Sladen	Arafura Sea.	140	Blue mud.	(11)
**P. cylindratus*, Sladen	S. of Cape Verde Islands, 1° 47′ 0″ N., 24° 26′ 0″ W.	1850	Globigerina ooze.	(12)
Mediaster, Stimpson.				
M. æqualis, Stimpson	Puget Sound; San Francisco.	...	.....	(13)
Nectria, Gray.				
×*N. ocellifera* (Lamarck), Gray	Bass Strait.	30–40	Sand and shells.	(14)
N. ocellata, Perrier	Bass Strait; Tasmania; Fiji Islands; Port Phillip (*fide* Bell).	...	.....	(15)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	+	...	...	...	...	...	...	...	A	...	.....
(2)	...	...	...	...	...	...	+	L	...	...	...	.....
(3)	+	...	...	...	...	...	...	...	...	A	37°·0	.....
(4)	...	...	...	...	+	...	...	L	...	...	...	.....
(5)	...	...	...	...	+	...	...	L	...	...	...	.....
(6)	+	...	...	...	...	...	...	...	C	A	39°·5–52°·5	= *Pentagonaster arenatus*, Perrier; *Dorigona arenata*, Perrier.
(7)	...	...	+	...	...	...	...	...	C	...	...	= *Pentagonaster* (*Dorigona*) *Moebii*, Studer.
(8)	+	...	...	...	...	...	...	...	C	A	...	= *Dorigona prehensilis*, Perrier.
(9)	+	...	...	...	...	...	...	...	C	...	...	= *Pentagonaster subspinosus*, Perrier; *Dorigona subspinosa*, Perrier.
(10)	+	...	...	...	...	...	...	...	C	A	...	= *Pentagonaster ternalis*, Perrier; *Dorigona ternalis*, Perrier.
(11)	...	...	...	...	+	...	...	L	...	...	...	.....
(12)	+	...	...	...	...	...	...	...	...	A	36°·6	.....
(13)	...	...	...	...	...	+	...	L	...	...	...	.....
(14)	...	...	...	...	...	...	+	L	...	...	...	= *Asterias ocellifera*, Lamarck; *Nectria ocellifera*, Gray; *Goniodiscus ocelliferus*, Müller and Troschel. Incl.: *Chætaster munitus*, Möbius.
(15)	...	...	...	...	...	...	+	L	...	...	...	= *Nectria ocellifera* (*pars*), Gray. Perhaps not specifically distinct from *Nectria ocellifera*.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA.				
Pentagonasteridæ.				
Subfamily Goniodiscinæ, Sladen.				
Stellaster, Gray.				
S. equestris (Retzius), Müller and Troschel . . .	China; Japan; Formosa; Port Darwin; Cape Cleveland.	...	.....	(1)
S. granulosus, Perrier, sp. . .	New South Wales.	...	.....	(2)
×*S. incei*, Gray . . .	Philippine Islands; Amboina; Sumatra; (?) Corean Strait; New Guinea; Arafura Sea; Torres Strait; N., N.E., and S. Australia.	4–50	Coral mud; Green mud; Blue mud.	(3)
**S. princeps*, Sladen . . .	Torres Strait.	6	Coral mud.	(4)
S. squamulosus, Studer . .	N.W. Australia.	60	.....	(5)
S. tuberculosus, von Martens .	China (*fide* Perrier).	...	.....	(6)
Ogmaster, von Martens.				
O. capella (Müller and Troschel), von Martens . . .	(?) China or Japan.	...	.....	(7)
Leptogonaster, Sladen.				
**L. cristatus*, Sladen . . .	Off the Philippine Islands.	100–115	Green mud.	(8)
Goniodiscus, Müller and Troschel, *emend.* Perrier.				
G. articulatus (Linné), de Loriol	Singapore; Mergui Archipelago.	Sub-littoral.	.....	(9)
G. cuspidatus (Lamarck), Müller and Troschel . . .	"Mers australes" (Peron and Lesueur).	?	.....	(10)
G. forficulatus, Perrier . .	Migupou.	...	.....	(11)
G. gracilis, Gray . . .	Moluccas.	...	.....	(12)
G. granuliferus (Gray), Perrier .	China (*fide* Perrier).	...	.....	(13)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	...	...	...	+	+	+	L	...	...	...	= *Asterias equestris*, Retzius; *Goniaster* (*Stellaster*) *equestris*, von Martens; *Goniaster equestris*, Lütken. Incl.: *Stellaster Childreni*, Gray; *Goniaster* (*Stellaster*) *Mülleri*, von Martens; *Pentagonaster* (*Stellaster*) *Childreni*, Perrier.
(2)	...	...	...	...	...	...	+	L	...	...	...	= *Pentagonaster* (*Stellaster*) *granulosus*, Perrier.
(3)	...	...	...	...	+	+	+	L	...	...	...	= *Pentagonaster* (*Stellaster*) *Incei*, Perrier. Incl.: *Stellaster Belcheri*, Gray; *Stellaster gracilis*, Möbius; *Pentagonaster* (*Stellaster*) *Belcheri*, Perrier.
(4)	...	...	...	...	+	...	...	L	...	...	...	.....
(5)	...	...	+	...	...	...	...	L	...	...	...	= *Pentagonaster* (*Stellaster*) *squamulosus*, Studer.
(6)	...	...	...	...	...	+	...	?	...	...	...	= *Goniaster* (*Stellaster*) *tuberculosus*, von Martens; *Pentagonaster* (*Stellaster*) *tuberculosus*, Perrier.
(7)	...	..	...	...	...	+	...	?	...	...	...	= *Goniodiscus capella*, Müller and Troschel; *Goniaster* (*Ogmaster*) *capella*, von Martens. Incl.: *Dorigona Reevesii*, Gray; *Hosea* (?) *capella*, Gray; *Goniaster Mülleri*, Lütken.
(8)	...	...	...	...	+	...	...	L	...	...	...	.....
(9)	...	...	+	...	+	...	...	L	...	...	...	= *Asterias articulata*, Linné; *Artocreatis altera species*, Seba; *Goniaster articulatus*, Lütken.
(10)	...	...	...	...	...	...	...	?	...	...	...	= *Asterias cuspidata*, Lamarck; *Hosea* (?) *cuspidata*, Gray.
(11)	...	...	...	...	?	...	...	...	...	...	...	.....
(12)	...	...	...	...	+	...	...	...	...	...	...	.....
(13)	...	...	...	...	...	+	...	L	...	...	...	= *Anthenea granulifera*, Gray.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA. *Pentagonasteridæ.* Goniodiscinæ.				
Goniodiscus, Müller and Troschel.				
G. pedicellaris, Perrier .	Barbados; St. Vincent; St. Lucia.	115–180	Fine black sand; Hard ground.	(1)
G. penicillatus, Philippi . .	Puerto Montt (Chili).	...	.....	(2)
G. pleyadella (Lamarck), Müller and Troschel . .	Moluccas.	...	.....	(3)
G. sebæ, Müller and Troschel	Red Sea; Mauritius; Madagascar; Ceylon; Eastern Archipelago; Fiji Islands; New Guinea.	...	.....	(4)
G. seriatus, Müller and Troschel	S.W. Australia.	...	.....	(5)
G. studeri, de Loriol . . .	Mauritius.	...	.....	(6)
Subfamily Mimasterinæ, Sladen.				
Mimaster, Sladen.				
**M. cognatus*, Sladen . . .	Off the W. coast of S. America.	245–1325	Blue mud.	(7)
M. tizardi, Sladen . . .	Faeröe Channel.	516–555	Mud.	(8)
Pentagonasteridæ *incertæ sedis:*				
Anthenoides, Perrier.				
A. peircei, Perrier . .	Barbados; Guadeloupe; St. Lucia.	84–151	Hard ground.	(9)
Hoplaster, Perrier.				
H. spinosus, Perrier . .	"Travailleur" 1881, Drag. No. 3. ...	1261	.....	(10)
Family *Antheneidæ*, Perrier.				
Anthenea, Gray.				
×*A. acuta*, Perrier . . .	Port Jackson; Madras.	6–15	.....	(11)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	+	...	...	...	...	...	...	L	C	...	50°·75–56°·0	.....
(2)	...	...	...	...	...	...	+	L	...	...	...	.....
(3)	...	...	...	...	+	...	...	L	...	...	...	= *Asterias pleyadella*, Lamarck; *Goniaster pleyadella*, von Martens; *Hosea* (?) *pleyadella*, Gray.
(4)	...	...	+	...	+	...	+	L	...	...	...	= *Hosea* (?) *Sebæ*, Gray; *Goniaster Sebæ*, von Martens.
(5)	...	...	+	...	...	...	...	L	...	...	...	.....
(6)	...	...	+	...	...	...	...	L	...	...	...	.....
(7)	...	...	...	...	...	...	+	...	C	A	36°·0–46°·0	.....
(8)	+	...	...	...	...	...	...	...	...	A	45°·4–46°·0	.....
(9)	+	...	...	...	...	...	...	L	...	...	61°·5	.....
(10)	+	...	...	...	...	...	...	...	...	A	...	.....
(11)	...	...	+	...	...	...	+	L	...	...	...	= *Goniodiscus acutus*, Perrier (*olim*).

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA. *Antheneidæ.*				
Anthenea, Gray.				
A. articulata, Perrier .	Seychelle Islands; China (*fide* Perrier).	...	.....	(1)
A. flavescens (Gray), Perrier	Port Jackson; Freemantle, W. Australia (*fide* Bell).	0–5	.....	(2)
A. grayi, Perrier . . .	? ...	?	?	(3)
A. pentagonula (Lamarck), Perrier	Hong Kong; Madras (*fide* Bell); N.W. Australia (*fide* Studer).	5	.....	(4)
×*A. tuberculosa*, Gray . .	Port Essington (N. Australia), Torres Strait; Port Jackson (*fide* Bell).	6 . .	Coral mud.	(5)
A. (?) *spinulosa*, Gray, sp. .	Philippine Islands; Timor; Fiji Islands; N.E. Australia.	...	Coral reefs.	(6)
Goniaster (Agassiz), *emend.* Perrier.				
G. obtusangulus (Lamarck), Perrier	Indian Ocean (?).	...	....	(7)
Hippasteria, Gray.				
×*H. plana* (Linck), Gray .	Off the British, Scandinavian, and Murman coasts; off E. of North America, N. of Cape Cod.	30–150	Clay, gravel, stones.	(8)
Family *Pentacerotidæ*, Gray, *emend.* Perrier.				
Pentaceros, Linck.				
P. affinis, Müller and Troschel, sp.	India.	...	.....	(9)
P. alveolatus, Perrier . .	New Caledonia.	...	.....	(10)
P. australis, Lütken, sp. . .	Australia. ...	...	.....	(11)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	...	...	+	...	...	?	...	L	...	...	...	.....
(2)	...	...	+	...	...	...	+	L	...	...	...	= *Hosia flavescens* (*pars*), Gray.
(3)	...	...	...	...	...	...	...	L	...	...	...	= *Hosia flavescens* (*pars*), Gray.
(4)	...	...	+	...	...	+	...	L	...	...	...	= *Asterias pentagonula*, Lamarck; *Goniodiscus pentagonulus*, Müller and Troschel; *Goniaster pentagonulus*, von Martens. Incl.: *Anthenea chinensis*, Gray; *Goniodiscus articulatus*, Perrier.
(5)	...	...	...	...	+	...	+	L	...	...	...	.....
(6)	...	...	...	...	+	...	+	L	...	...	...	= *Hosia spinulosa*, Gray; *Goniaster* (*Hosia*) *spinulosa*, von Martens; *Pentagonaster* (*Astrogonium*) *spinulosus*, Perrier.
(7)	...	...	?	...	...	...	...	L	...	...	...	= *Asterias obtusangula*, Lamarck; *Oreaster obtusangulus*, Müller and Troschel; *Pentaceros obtusangulus*, Gray.
(8)	+	...	...	...	...	...	...	L	...	...	...	= *Pentaceros planus*, Linck. Incl.: *Asterias equestris* (*pars*), Linné; *Asterias phrygiana*, Parelius; *Asterias Johnstoni*, Gray; *Hippasteria europæa*, Gray; *Hippasteria Johnstoni*, Gray; *Hippasteria cornuta*, Gray; *Goniaster equestris*, Forbes; *Astrogonium phrygianum*, Müller and Troschel; *Goniaster abbensis*, Forbes; *Astrogonium aculeatum*, Barrett; *Goniaster phrygianus*, Norman; *Hippasteria phrygiana*, Verrill; *Pentagonaster* (*Astrogonium*) *aculeatus*, Perrier.
(9)	...	...	+	...	...	...	...	L	...	...	...	= *Oreaster affinis*, Müller and Troschel.
(10)	...	...	...	...	...	...	+	L	...	...	...	= *Oreaster alveolatus*, Bell.
(11)	...	...	...	...	...	...	?	L	...	...	...	= *Oreaster australis*, Lütken.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA. *Pentacerotidæ.*				
Pentaceros, Linck.				
P. belli, de Loriol	Mauritius.	...	.....	(1)
P. caledonicus, Perrier	New Caledonia.	...	.....	(2)
**P. callimorphus*, Sladen	Torres Strait.	6	Coral mud.	(3)
P. carinatus, Müller and Troschel, sp.	Adriatic (?).	...	.....	(4)
P. chinensis, Gray	China.	...	.....	(5)
P. cumingi, Gray	Guayaquil.	...	.....	(6)
P. decipiens, Bell, sp.	Billiton.	...	.....	(7)
×*P. dorsatus* (Linné), Perrier	Cape Verde Islands.	...	.....	(8)
P. forcipulosus, Lütken	Coast of Guinea (W. Africa).	...	.....	(9)
P. gracilis, Lütken, sp.	East Australia; Port Denison; Port Molle, Queensland (*fide* Bell).	4	.....	(10)
P. granulosus, Gray	Swan River; Freemantle.	...	.....	(11)
P. grayi, Bell, sp.	Billiton; Mauritius; (?) Zanzibar.	...	.....	(12)
P. hedemanni, Lütken, sp.	Billiton.	...	.....	(13)
P. hiulcus, Linck	Zanzibar; Mauritius; New Ireland (*fide* Studer).	...	.....	(14)
P. luetkeni, Bell, sp.	Billiton.	...	.....	(15)
P. mammillatus (Audouin), Perrier	Red Sea; Mauritius.	...	.....	(16)
P. muricatus, Linck	Zanzibar; Madagascar; Mauritius; Seychelles; Ceylon; Madras; Eastern Archipelago; New Britain.	...	.....	(17)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0-150 Fathoms. L.	Continental, 150-500 Fathoms. C	Abyssal, greater than 500 Fathoms. A.		
(1)	...	...	+	...	...	...	...	L	...	...	...	.....
(2)	...	...	...	...	...	...	+	L	...	...	...	.....
(3)	...	...	...	...	+	...	...	L	...	...	...	.....
(4)	?	...	...	...	...	...	...	L	...	...	...	= *Oreaster carinatus*, Müller and Troschel.
(5)	...	...	...	...	...	+	...	L	...	...	...	= *Oreaster chinensis*, Müller and Troschel.
(6)	...	...	...	...	...	...	+	L	...	...	...	Probably includes *Oreaster occidentalis*, Verrill.
(7)	...	...	...	...	+	...	...	L	...	...	...	= *Oreaster decipiens*, Bell.
(8)	+	...	...	...	...	...	...	L	...	...	...	= *Asterias dorsatus*, Linné; *Oreaster dorsatus*, Lütken. Incl.: *Asterias nodosa* (*pars*), Linné; *Oreaster clavatus*, Müller and Troschel.
(9)	+	...	...	...	...	...	...	L	...	...	...	.....
(10)	...	...	...	...	...	...	+	L	...	...	...	= *Oreaster gracilis*, Lütken.
(11)	...	...	+	...	...	...	...	L	...	...	...	= *Oreaster granulosus*, Bell. (A doubtful member of the genus.)
(12)	...	...	+	...	+	...	...	L	...	...	...	= *Pentaceros nodosa*, Gray (*non* Linné); *Oreaster nodosus*, Müller and Troschel; *Oreaster grayi*, Bell. Incl.: *Oreaster Clouei*, Perrier. (Probably the same species as *Pentaceros verrucosus*, Müller and Troschel, sp., which has priority.)
(13)	...	...	...	...	+	...	...	L	...	...	...	= *Oreaster Hedemanni*, Lütken.
(14)	...	...	+	...	...	...	+	L	...	...	...	= *Pentaceros gibbus, hiulcus*, Linck; *Oreaster hiulcus*, Müller and Troschel.
(15)	...	...	...	...	+	...	...	L	...	...	...	= *Oreaster luetkeni*, Bell.
(16)	...	...	+	...	...	...	...	L	...	...	...	= *Asterias mammillata*, Audouin; *Oreaster mammillatus*, Müller and Troschel.
(17)	...	...	+	...	+	...	+	L	...	...	...	= *Pentaceros gibbus, muricatus*, Linck; *Pentaceros muricatus*, Gray. Incl.: *Asterias Linkii*, de Blainville; *Oreaster muricatus*, Dujardin and Hupé; *Oreaster Linckii*, Lütken; *Oreaster castellum*, Grube; *Oreaster nodosus*, var. *muricatus*, von Martens.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA. *Pentacerotidæ.*				
Pentaceros, Linck.				
P. muelleri, Bell, sp.	Billiton.	...	.....	(1)
P. nodulosus, Perrier	W. and N.W. Australia.	...	.....	(2)
P. occidentalis, Verrill, sp.	Margarita Bay; Cape San Lucas; Panama; Guayaquil.	12–18	Rocky ground.	(3)
P. orientalis, Müller and Troschel, sp.	China; New Britain (*fide* Studer).	...	.....	(4)
P. productus, Bell, sp.	Billiton.	...	.....	(5)
**P. productus*, var. *tuberata*, Sladen	Off Philippine Islands.	10	Sand.	(6)
P. regulus (Val.), Müller and Troschel, sp.	Pondicherry (Bay of Bengal).	...	.....	(7)
P. reinhardti, Lütken, sp.	Nicobar Islands.	...	.....	(8)
P. reticulatus, Linck	Florida; Bahamas; Barbados; Antilles; Brazil; Abrolhos reefs; Freemantle (West Australia.	...	.....	(9)
P. sladeni, de Loriol	Mauritius.	...	.....	(10)
P. superbus, Möbius, sp.	Sumatra; Madras (*fide* Bell).	...	.....	(11)
P. thurstoni, Bell, sp.	Tuticorin (Madras).	...	.....	(12)
P. troscheli, Bell, sp.	Billiton.	...	.....	(13)
P. tuberculatus, Müller and Troschel	Red Sea; E. coast of Africa.	...	.....	(14)
×*P. turritus*, Linck	Indian Ocean generally; Eastern Archipelago; New Guinea; Port Essington; Cape Grenville; Port Denison; New Caledonia; New Britain.	4–28	.....	(15)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0-150 Fathoms. L.	Continental, 150-500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	...	...	...	...	+	...	...	L	...	...	...	= *Oreaster muelleri*, Bell.
(2)	...	...	+	...	...	...	...	L	...	...	...	= *Oreaster nodulosus*, Bell.
(3)	...	...	...	...	...	+	+	L	...	...	...	= *Oreaster accidentalis*, Verrill. (Probably the same species as *Pentaceros Cumingii*, Gray.)
(4)	...	...	...	...	...	+	+	L	...	...	...	= *Oreaster orientalis*, Müller and Troschel.
(5)	...	...	...	...	+	...	...	L	...	...	...	= *Oreaster productus*, Bell.
(6)	...	...	...	...	+	...	...	L	...	...	...	.....
(7)	...	...	+	...	...	...	...	L	...	...	...	= *Oreaster regulus*, Müller and Troschel.
(8)	...	...	+	...	...	...	...	L	...	...	...	= *Oreaster Reinhardti*, Lütken.
(9)	+	+	+	...	...	...	...	L	...	...	...	= *Pentaceros gibbus, reticulatus*, Linck; *Asterias reticulata*, Linné; *Oreaster reticulatus*, Müller and Troschel. Incl.: *Pentaceros lentiginosus*, Linck; *Asterias gigas*, Linné; *Asterias pentacyphus*, Retzius; *Asterias Sebæ*, de Blainville; *Pentaceros grandis*, Gray; *Pentaceros gibbus*, Gray; *Pentaceros aculeatus*, Gray; *Oreaster aculeatus*, Müller and Troschel; *Oreaster lapidarius*, Grube; *Oreaster gigas*, Lütken; *Pentaceros tuberosus* (Behn, M.S.), Möbius.
(10)	...	...	+	...	...	...	...	L	...	...	...	.....
(11)	...	...	+	...	+	...	...	L	...	...	...	= *Oreaster superbus*, Möbius.
(12)	...	...	+	...	...	...	...	L	...	...	...	= *Oreaster thurstoni*, Bell.
(13)	...	...	...	...	+	...	...	L	...	...	...	= *Oreaster troscheli*, Bell.
(14)	...	...	+	...	...	...	...	L	...	...	...	= *Oreaster tuberculatus*, Müller and Troschel. (Probably the same as *Pentaceros mammillatus* (Audouin), Perrier.)
(15)	...	...	+	...	+	...	+	L	...	...	...	= *Pentaceros gibbus, turritus*, Linck; *Oreaster turritus*, Müller and Troschel. Incl.: *Asterias nodosa* (*pars*), Linné; *Pentaceros Franklinii*, Gray; *Pentaceros modestus*, Gray; *Oreaster mammosus*, Perrier; *Oreaster nodosus*, Bell.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA.				
Pentacerotidæ.				
Pentaceros, Linck.				
P. valvulatus, Müller and Troschel	S.W. Australia.	...	.....	(1)
P. verrucosus, Müller and Troschel, sp.	India.	...	.....	(2)
P. westermanni, Lütken, sp.	Bengal.	...	.....	(3)
Nidorellia, Gray.				
N. armata (Gray), Verrill	W. coast of Central America, extending from California to Ecuador.	...	.....	(4)
N. michelini, Perrier	Mazatlan.	...	.....	(5)
Amphiaster, Verrill.				
A. insignis, Verrill	La Paz.	...	.....	(6)
Pentaceropsis, Sladen.				
×*P. obtusatus*, Bory de Saint Vincent, sp.	Philippine Islands; Mauritius (?).	Shallow.	.....	(7)
Culcita, Agassiz.[4]				
C. acutispina, Bell	New Hebrides.	...	.....	(8)
C. arenosa (Val.), Perrier	Sandwich Islands.	...	.....	(9)
C. coriacea, Müller and Troschel	Red Sea; Mozambique; Mauritius.	...	.....	(10)
C. grex, Müller and Troschel	Molucca; Andaman Islands (*fide* Bell).	...	.....	(11)
×*C. novæ-guineæ*, Müller and Troschel	New Guinea; New Hanover; N.E. Australia; Nicobar Islands (*fide* Lütken).	10	Sand.	(12)
C. pentangularis, Gray	Mozambique; Torres Strait; Fiji Islands; N.E. and W. Australia.[5]	...	.....	(13)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	...	+	...	...	...	...	L	...	...	...	= *Oreaster valvulatus*, Müller and Troschel.
(2)	...	...	?	...	...	...	...	L	...	...	...	*Oreaster verrucosus*, Müller and Troschel. Probably includes *Pentaceros nodosus*, Gray (*non* Linné), *Oreaster nodosus*, Müller and Troschel, *Oreaster Clouei*, Perrier, and *Oreaster grayi*, Bell.
(3)	...	...	+	...	...	...	...	L	...	...	...	= *Oreaster Westermanni*, Lütken.
(4)	...	...	...	...	...	+	+	L	...	...	...	= *Pentaceros* (*Nidorellia*) *armatus*, Gray; *Oreaster armatus*, Müller and Troschel; *Goniodiscus armatus*, Lütken. Incl.: *Goniodiscus conifer*, Möbius; *Goniodiscus stella*, Verrill.
(5)	...	...	...	...	...	+	...	L	...	...	...	= *Goniodiscus Michelini*, Perrier; *Oreaster armatus* (*pars*), Lütken.
(6)	...	...	...	...	...	+	...	L	...	...	...	.....
(7)	...	...	?	...	+	...	...	L	...	...	...	= *Asterias obtusatus*, Bory de Saint Vincent; *Oreaster obtusatus*, Müller and Troschel; *Pentaceros obtusatus*, Perrier.
(8)	...	...	...	...	...	...	+	L	...	...	...	.....
(9)	...	...	...	...	...	+	...	L	...	...	...	.....
(10)	...	...	+	...	...	...	...	L	...	...	...	.....
(11)	...	...	+	...	+	...	...	L	...	...	...	Incl.: *Culcita Novæ Guineæ*, Perrier (*olim*).
(12)	...	...	...	...	+	...	+	L	...	...	...	Incl.: *Culcita pulverulenta* (Val.), Perrier.
(13)	...	...	+	...	+	...	+	L	...	...	...	Incl.: *Randasia granulata*, Gray; *Culcita grex*, Perrier (*olim*).

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA. *Pentacerotidæ.*				
Culcita, Agassiz.				
C. schmideliana (Retzius), Gray	Red Sea; Zanzibar; Madagascar; Mauritius; Ceylon; (?) Andaman Islands (*fide* Bell); Amboina; Galapagos Islands (*fide* Gray).	...	.....	(1)
C. veneris, Perrier . . .	St. Paul Island.	...	.....	(2)
Asterodiscus, Gray.				
×*A. elegans*, Gray . .	Philippine Islands; N.E. China.	10	.....	(3)
Choriaster, Lütken.				
×*C. granulatus*, Lütken	Philippine Islands; Pelew Islands; Fiji Islands; New Zealand.	10	.....	(4)
Paulia, Gray.				
P. horrida, Gray . . .	Punta Santa Elena (Ecuador)	...	.....	(5)
Family *Gymnasteriidæ*, Perrier.				
Asteropsis, Müller and Troschel.				
A. vernicina (Lamarck), Müller and Troschel..... . .	Panama (*fide* Perrier); Port Jackson (*fide* Bell).	...	.....	(6)
Dermasterias, Perrier.				
D. imbricata (Grube), Perrier	From Vancouver Island to San Francisco.	...	.....	(7)
Gymnasteria, Gray.				
×*G. carinifera* (Lamarck), von Martens . . .	Red Sea; Mauritius; Ceylon; Eastern Archipelago; New Caledonia; Fiji Islands; Sandwich Islds.; Panama.	Shallow.	.....	(8)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	...	+	...	+	...	?	L	...	...	...	= *Asterias schmideliana*, Retzius. Incl.: *Asterias discoidea*, Lamarck; *Culcita discoidea*, Agassiz.
(2)	...	...	...	+	...	...	...	L	...	...	...	.....
(3)	...	...	...	...	+	+	...	L	...	...	...	.....
(4)	...	...	...	...	+	+	+	L	...	...	...	.....
(5)	...	...	...	...	...	...	+	L	...	...	...	= *Goniodiscus* (?) *horridus*, Müller and Troschel; *Nidorellia horrida*, Perrier.
(6)	...	...	...	...	...	+	+	L	...	...	...	= *Asterias verniciña*, Lamarck. Incl.: *Petricia punctata*, Gray.
(7)	...	...	...	...	...	+	...	L	...	...	...	= *Asteropsis imbricata*, Grube. Incl.: *Gymnasteria inermis*, Verrill (*non* Gray) (?).
(8)	...	...	+	...	+	+	+	L	...	...	...	= *Asterias carinifera*, Lamarck; *Asterope carinifera*, Müller and Troschel; *Asteropsis carinifera*, Müller and Troschel. Incl.: *Gymnasteria spinosa*, Gray; *Gymnasteria inermis*, Gray; *Gymnasterias biserrata*, von Martens (?).

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA. *Gymnasteriidæ.*				
Gymnasteria, Gray.				
(?) *G. biserrata*, von Martens .	Larentuka.	...	.....	(1)
G. valvulata, Perrier . . .	Galapagos Islands.	...	.....	(2)
Tylaster, Danielssen and Koren.				
T. willei, Danielssen and Koren	Off Spitzbergen, and between Spitzbergen and Norway.	416–1200	Clay; Biloculina clay; Bluish green clay.	(3)
Porania, Gray.				
×*P. antarctica*, Smith . .	Kerguelen; Marion Island; Prince Edward Island; Crozet Islands; South Georgia.	50–1600	Diatom ooze (1600 fathoms).	(4)
**P. glaber*, Sladen . . .	Kerguelen Island.	30–127	.....	(5)
P. grandis, Verrill . . .	E. of North America.	66–373	.....	(6)
×*P. magellanica*, Studer .	Off Patagonia; in Strait of Magellan.	45	Green sand.	(7)
P. pulvillus (O. F. Müller), Norman . . .	Off the coasts of Scandinavia and Britain.	15–106	.....	(8)
**P. spiculata*, Sladen . .	Off Heard Island; off the Arrou Islands.	75–800	Coarse gravel; Volcanic mud; Green mud.	(9)
Marginaster, Perrier.				
M. echinulatus, Perrier . .	Off Barbados.	69	.....	(10)
M. fimbriatus, Sladen . .	N. of Ireland.	1360	.....	(11)
M. pectinatus, Perrier . .	Off coast of Yucatan.	95	.....	(12)
M. pentagonus, Perrier . .	"Talisman" dredging, No. 37.	218	.....	(13)
M. (?) *capreensis*, Gasco, sp. .	Off Island of Capri.	54–82	.....	(14)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	...	...	...	+	...	...	L	...	...	...	Probably the young form of *Gymnasteria carinifera* (Lamarck), von Martens.
(2)	...	...	...	...	...	...	+	L	...	...	...	Type probably a young form.
(3)	+	...	...	...	...	...	...	...	C	A	29°·1–33°·4	.....
(4)	...	+	...	+	...	...	...	L	C	A	34°·2	.....
(5)	...	...	...	+	...	...	...	L	...	...	...	.....
(6)	+	...	...	...	...	...	...	L	C	...	...	.....
(7)	...	...	...	...	...	...	+	L	...	...	...	Incl.: *Porania patagonica*, Perrier (?).
(8)	+	...	...	...	...	...	...	L	...	...	...	= *Asterias pulvillus*, O. F. Müller; *Asteropsis pulvillus*, Müller and Troschel. Incl.: *Goniaster Templetoni*, Forbes; *Porania gibbosa*, Gray; *Asteropsis ctenacantha*, Müller and Troschel.
(9)	...	...	...	+	+	...	...	L	C	A	35°·2–39°·5	.....
(10)	+	...	...	...	...	...	...	L	...	...	...	.....
(11)	+	...	...	...	...	...	...	...	...	A	35°·7	.....
(12)	+	...	...	...	...	...	...	L	...	...	...	.....
(13)	+	...	...	...	...	...	...	...	C	...	...	.....
(14)	+	...	...	...	...	...	...	L	...	...	...	= *Asteropsis capreensis*, Gasco.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA. *Gymnasteriidæ.*				
Rhegaster, Sladen.				
R. murrayi, Sladen . . .	In the Faeröe Channel.	285–433	.....	(1)
R. tumidus, Stuxberg, sp. .	Off Nova Zembla, Spitzbergen, the coasts of Norway and Siberia.	5–658	Clay, Blue clay, Stony ground.	(2)
R. tumidus, var. *tuberculata* (Danielssen and Koren) .	Between Norway and Spitzbergen.	146–457	Grey sandy clay; Blue clay; Hard.	(3)
Poraniomorpha, Danielssen and Koren				
P. borealis, Verrill . . .	E. of North America.	192–225	.....	(4)
P. rosea, Danielssen and Koren .	N.W. of Bergen.	220	Ooze and Clay.	(5)
P. spinulosa, Verrill . . .	E. of North America.	122–250	.....	(6)
Lasiaster, Sladen.				
L. hispidus, Sars, sp. . .	Off the Lofoten Islands; and between Spitzbergen and the Scandinavian coast.	107–300	Greenish clay, Stones, and Clay.	(7)
L. villosus, Sladen . . .	In the Faeröe Channel.	542	.....	(8)
Family *Asterinidæ*, Gray, *emend.* Perrier. Subfamily Ganeriinæ, Sladen.				
Cycethra, Bell.				
**C. electilis*, Sladen . . .	Off the Falkland Islands.	12	Sand and gravel.	(9)
**C. nitida*, Sladen . .	Off Cape Virgins, off Strait of Magellan.	55	Sand.	(10)
**C. pinguis*, Sladen . .	Off Cape Virgins, off Strait of Magellan.	55	Sand.	(11)
C. simplex, Bell . .	Trinidad Channel, W. coast of Patagonia; off Buenos Ayres (*fide* Studer)	30	Sand.	(12)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0-150 Fathoms.	Continental, 150-500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	+	...	...	...	...	...	...	...	C	...	40°·8–43°·5	.....
(2)	+	...	...	...	...	...	...	L	C	A	...	= *Solaster tumidus*, Stuxberg; *Asterina tumida*, Danielssen and Koren.
(3)	+	...	...	...	...	...	...	L	C	...	30°·0–33°·9	= *Asterina tumida*, var. *tuberculata*, Danielssen and Koren.
(4)	+	...	...	...	...	...	...	...	C	...	...	= *Asterina borealis*, Verrill (*olim*).
(5)	+	...	...	...	...	...	...	...	C	...	42°·8	.....
(6)	+	..	...	...	...	...	...	L	C	...	...	= *Porania spinulosa*, Verrill (*olim*).
(7)	+	...	...	...	...	...	...	L	C	...	...	= *Goniaster hispidus*, Sars; *Pentagonaster* (*Astrogonium*) *hispidus*, Perrier.
(8)	+	...	...	...	...	...	...	...	...	A	43°·7	.....
(9)	...	+	...	...	...	...	...	L	...	...	...	.....
(10)	...	+	...	...	...	...	...	L	...	...	47°·8	.....
(11)	...	+	...	...	...	...	...	L	...	...	47°·8	.....
(12)	...	+	...	...	...	...	+	L	...	...	...	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA. *Asterinidæ.* Ganeriinæ.				
Ganeria, Gray.				
×*G. falklandica*, Gray . .	Off Falkland Islands and off Cape Virgins.	55	Sand.	(1)
Subfamily Asterininæ, Sladen.				
Patiria, Gray, *emend.* Perrier.				
**P. bellula*, Sladen . .	Simon's Bay (Cape of Good Hope).	Shallow.	.....	(2)
P. crassa, Gray . . .	W. Australia; Port Curtis; Port Phillip.	...	.....	(3)
P. ocellifera, Gray . . .	W. Australia (*fide* T. Woods).	...	.....	(4)
Nepanthia, Gray.				
N. belcheri, Perrier, sp. . .	Port Jackson (*fide* Bell).	0–4	.....	(5)
×*N. brevis*, Perrier, sp. .	Torres Strait, N.W. Australia (*fide* Studer).	2–70	Shell sand, Coral mud.	(6)
×*N. maculata*, Gray . .	Arafura Sea; Migupou (*fide* Gray); off New Guinea (*fide* Studer).	28–400	Green mud.	(7)
N. suffarcinata, Sladen . .	Mergui Archipelago.	...	.....	(8)
Asterina, Nardo.				
A. calcar (Lamarck), Gray	S. and S.E. Australia; (?) Tasmania.	...	.....	(9)
A. calcarata (Val.), Perrier .	Chili.	...	.....	(10)
×*A. cepheus* (Müller and Troschel), von Martens . . .	Red Sea; Mozambique; Zanzibar; Ceylon; Nicobar Islands; Madras; Mergui; Java; Philippines; Torres Strait; New Guinea; New Caledonia.	10	Coral reefs.	(11)
A. chilensis, Lütken . . .	Peru; Chili.	...	.....	(12)
A. coccinea (Müller and Troschel), Perrier. . .	Cape of Good Hope; Mozambique.	...	.....	(13)
A. coronata, von Martens . .	Mozambique; Moluccas.	...	.....	(14)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	+	...	...	...	...	...	L	...	...	47°·8	.....
(2)	...	+	...	...	...	...	...	L	...	...	...	.....
(3)	...	...	+	...	...	...	+	L	...	...	...	.....
(4)	...	...	+	...	...	...	...	L	...	...	...	.....
(5)	...	...	...	...	...	...	+	L	...	...	...	= *Asterina* (*Nepanthia*) *Belcheri*, Perrier; *Asterina belcheri*, Bell; *Nepanthia belcheri*, Bell.
(6)	...	...	...	...	+	...	...	L	...	...	...	= *Asterina* (*Nepanthia*) *brevis*, Perrier.
(7)	...	...	...	...	+	...	...	L	...	...	...	*Chætaster* (?) *maculatus*, Müller and Troschel; *Chætaster cylindratus*, Möbius (?); *Asterina* (*Nepanthia*) *maculata*, Perrier.
(8)	...	...	+	...	...	...	...	L	...	...	...	.....
(9)	...	...	...	...	...	...	+	L	...	...	...	= *Asterias calcar*, var. *c*, *octogona*, Lamarck; *Asteriscus australis* (*pars*), Müller and Troschel.
(10)	...	...	...	...	...	...	+	L	...	...	...	= *Asteriscus calcaratus*, Valenciennes.
(11)	...	...	+	...	+	...	+	L	...	...	...	= *Asteriscus cepheus*, Müller and Troschel. Incl.: *Asterina Burtonii*, Gray.
(12)	...	...	...	...	...	...	+	L	...	...	...	= *Patiria chilensis*, Verrill.
(13)	...	+	+	...	...	...	...	L	...	...	...	= *Asteriscus coccineus*, Müller and Troschel; *Patiria coccinea*, Gray.
(14)	...	...	+	...	+	...	...	L	...	...	...	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA. *Asterinidæ.* Asterininæ.				
Asterina, Nardo.				
×*A. exigua* (Lamarck), Perrier	Cape of Good Hope; Natal; Madagascar; Mauritius; Java; Moluccas; Philippine Islands; New Guinea; S. and E. Australia; St. Paul Island.	10	Coral reefs, &c.	(1)
A. fimbriata, Perrier	Island of Bourbon; Strait of Magellan.	...	.....	(2)
×*A. folium* (Lütken), Agassiz	Antilles; Bermuda.	...	.....	(3)
A. gayi, Perrier	Chili.	...	.....	(4)
A. gibbosa (Pennant), Forbes	Off European and N. African coasts; Mediterranean; Azores (*fide* Barrois). Also reputed to occur in the Indian Ocean and Eastern Archipelago; but probably *A. cepheus* is the species in question.	0–35	.....	(5)
A. granifera (Gray), Perrier	Cape of Good Hope.	...	.....	(6)
A. granulosa, Perrier	Sandwich Islands.	...	.....	(7)
×*A. gunnii*, Gray	Cape of Good Hope; Port Molle; South Australia; Port Phillip; Tasmania.	7	.....	(8)
A. lymani, Perrier	Barbados.	120–140	Broken shells and corals.	(9)
A. marginata (Val.), Perrier	Rio Janeiro; Senegal; (?) Canary Islands.	...	.....	(10)
A. miniata (Brandt), Perrier	Sitcha; California.	...	.....	(11)
A. minuta, Gray	Antilles.	...	.....	(12)
A. modesta (Verrill), Perrier	Panama; Pearl Islands.	...	.....	(13)
A. novæ-zealandiæ, Perrier	New Zealand.	...	.....	(14)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	...	+	+	+	+	...	+	L	...	...	...	=*Asterias exigua*, Lamarck. Incl.: *Asterias minuta*, de Blainville; *Asterina Kraussii*, Gray; *Asteriscus pentagonus*, Müller and Troschel; *Asteriscus Kraussii*, Müller and Troschel; *Asterina pentagona*, von Martens.
(2)	...	+	+	...	...	...	...	L	...	...	...	.....
(3)	+	...	...	...	...	...	...	L	...	...	...	=*Asteriscus folium*, Lütken.
(4)	...	...	...	...	...	...	+	L	...	...	...	=*Asteriscus calcaratus*, Val., M.S. (*pars*).
(5)	+	...	?	...	?	...	...	L	...	...	...	=*Asterias gibbosa*, Pennant; *Asteriscus gibbosus*, Fischer. Incl.: *Asterias verruculata*, Retzius; *Asterias exigua*, Delle Chiaje; *Asterias pulchella*, de Blainville; *Asterina minuta*, Nardo; *Asteriscus verruculata*, Müller and Troschel.
(6)	...	+	...	...	...	...	...	L	...	...	...	=*Patiria granifera*, Gray.
(7)	...	...	...	...	...	+	...	L	...	...	...	.....
(8)	...	+	...	...	...	...	+	L	...	...	...	=*Asterias calcar*, var. *b.*, Lamarck; *Asteriscus australis* (*pars*), Müller and Troschel. Incl.: *Asteriscus Diesingi*, Müller and Troschel; *Asteriscus calcar*, Dujardin and Hupé; *Asteriscus exiguus*, Perrier (*olim*).
(9)	+	...	...	...	...	...	...	L	...	...	56°·5–61°	.....
(10)	+	+	...	...	...	...	...	L	...	...	...	=*Asteriscus marginatus* (Valenciennes, M.S.), Perrier. Incl.: *Asteriscus minutus*, Müller and Troschel; *Asteriscus stellifer*, Möbius; *Asteriscus brasiliensis*, Lütken; *Asterina stellifera*, Lütken; (?)*Asteriscus arrecifiensis*, Greeff.
(11)	...	...	...	...	...	+	...	L	...	...	...	=*Asterias miniata*, Brandt.
(12)	+	...	...	...	...	...	...	L	...	...	...	.....
13)	...	...	...	...	...	+	...	L	...	...	...	=*Asterina* (*Asteriscus*) *modesta*, Verrill.
(14)	...	...	...	...	...	...	+	L	...	...	...	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA.				
Asterinidæ.				
Asterininæ.				
Asterina, Nardo.				
A. obtusa (Gray), Perrier	Panama.	1–2	.....	(1)
×*A. pectinifera* (Müller and Troschel), von Martens	Japan.	5–25	.....	(2)
×*A. penicillaris* (Lamarck), von Martens	Red Sea; Port Natal; Java; Flores; Moluccas; Australia; Japan.	8–50	.....	(3)
A. pilosa, Perrier	Dominica.	118	Fine sand and broken shells.	(4)
A. pusilla, Perrier	Talcahuano (Chili).	...	.....	(5)
A. pygmæa, Verrill	E. of North America.	...	.....	(6)
×*A. regularis*, Verrill	Port Molle; Port Jackson; New Zealand.	10	.....	(7)
A. setacea (Val.), Perrier	?	?	?	(8)
A. squamata (Val.), Perrier	Senegal.	...	.....	(9)
A. stellaris, Perrier	?	?	?	(10)
A. trochiscus (Retzius), Perrier	Indian Ocean (?)	....	.....	(11)
A. wega (Val.), Perrier	Red Sea; Mauritius.	...	.....	(12)
Disasterina, Perrier.				
D. abnormalis, Perrier	New Caledonia.	...	.....	(13)
D. ceylanica, Döderlein	Ceylon.	...	.....	(14)
Subfamily Palmipedinæ, Sladen.				
Palmipes, Linck.				
P. diaphanus, Sladen	N. of Admiralty Island.	150	Coral mud.	(15)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North America.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	...	...	...	...	+	...	L	...	...	...	= *Patiria obtusa*, Gray.
(2)	...	...	...	...	...	+	...	L	...	...	...	= *Asteriscus pectinifer*, Müller and Troschel.
(3)	...	...	+	...	+	+	+	L	...	...	...	= *Asterias penicillaris*, Lamarck; *Asteriscus penicillaris*, Müller and Troschel.
(4)	+	...	...	...	...	...	...	L	...	...	65°	.....
(5)	...	...	...	...	...	...	+	L	...	...	...	= *Asteriscus calcaratus*, Val., M.S. (*pars*).
(6)	+	...	...	...	...	...	...	...	...	...	...	.....
(7)	...	...	...	...	...	...	+	L	...	...	...	= *Asterina Gunnii*, var., Gray; *Asteriscus australis* (*pars*), Müller and Troschel; *Asterina* (*Asteriscus*) *regularis*, Verrill. Incl.: *Asterina cabbalistica*, Lütken.
(8)	...	...	...	...	...	...	...	L	...	...	...	= *Asteriscus setaceus* (Val.), Müller and Troschel.
(9)	+	...	...	...	...	...	...	L	...	...	...	= *Asteriscus squamatus* (Val.), Perrier (*olim*).
(10)	...	...	...	...	...	...	...	L	...	...	...	.....
(11)	...	...	...	...	...	...	...	L	...	...	...	= *Asterias trochiscus*, Retzius; *Asteriscus trochiscus*, Müller and Troschel.
(12)	...	...	+	...	...	...	...	L	...	...	...	= *Asteriscus wega* (Val.), Perrier (*olim*).
(13)	...	...	...	...	...	...	+	L	...	...	...	.....
(14)	...	...	+	...	...	...	...	L	...	...	...	.....
(15)	...	...	...	...	...	...	+	L	...	...	...	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
PHANEROZONIA. *Asterinidæ.* Palmipedinæ.				
Palmipes, Linck.				
P. membranaceus, Linck .	British Isles; English Channel; coast of France; Mediterranean; Adriatic.	20–100	.....	(1)
P. rosaceus (Lamarck), Dujardin and Hupé . . .	Japan; Bay of Bengal.	...	.....	(2)
Stegnaster, Sladen.				
S. inflatus, Hutton, sp. . .	New Zealand.	...	.....	(3)
S. wesseli, Perrier, sp. . .	Barbados; off Florida.	101	.....	(4)
Asterinidæ *incertæ sedis:*				
Tremaster, Verrill.				
T. mirabilis, Verrill . .	Off George's Bank, Nova Scotia, and Newfoundland.	150–250	.....	(5)
Order CRYPTOZONIA, Sladen. Family *Linckiidæ*, Perrier, *emend.* Subfamily Chætasterinæ, Sladen.				
Chætaster, Müller and Troschel.				
×*C. longipes* (Retzius), Sars .	Mediterranean; Azores; Bermuda; S. of Cape Palmas (*fide* Studer).	30–450	Coral; Volcanic mud.	(6)
C. nodosus, Perrier .	Guadeloupe; Cape Verde Islands (*fide* Studer).	...	.....	(7)
(?) *C. hermanni*, Müller and Troschel	?	?	?	(8)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	+	...	...	...	...	...	...	L	...	...	...	= *Asterias membranacea*, Retzius; *Anseropoda membranacea*, Nardo; *Asteriscus membranacea*, Müller and Troschel. Incl.: *Asterias placenta*, Pennant; *Asterias cartilaginea*, Fleming; *Asteriscus palmipes*, Müller and Troschel; *Palmipes placenta*, Norman.
(2)	...	...	+	...	...	+	...	L	...	...	...	= *Asterias rosacea*, var. *lobis quindenis*, Lamarck; *Asteriscus rosaceus*, Müller and Troschel. Incl.: *Palmipes Stokesii*, Gray.
(3)	...	...	...	...	...	...	+	L	...	...	...	= *Pteraster inflatus*, Hutton; *Palmipes inflatus*, Perrier.
(4)	+	...	...	...	...	...	...	L	...	...	61°·75	= *Asterina Wesseli*, Perrier.
(5)	+	...	...	...	...	...	...	...	C	...	...	.....
(6)	+	...	...	...	...	...	...	L	C	...	...	= *Asterias longipes*, Retzius; *Astropecten* (*Astropus*) *longipes*, Gray. Incl.: *Asterias subulata*, Lamarck; *Chætaster subulatus*, Müller and Troschel; *Nepanthia tessellata*, Gray.
(7)	+	...	...	...	...	...	...	L	...	...	...	.....
(8)	...	...	...	...	...	...	...	?	...	...	...	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA. *Linckiidæ*. Subfamily Linckiinæ, Sladen.				
Fromia, Gray.				
F. balansæ, Perrier	New Caledonia.	...	.....	(1)
F. indica, Perrier	Indian Ocean; Andaman Islands.	...	.....	(2)
F. japonica, Perrier	Japan.	...	.....	(3)
×*F. milleporella* (Lamarck), Gray	Red Sea; Mauritius; Madagascar; Ceylon; Moluccas; Amboina; New Caledonia; Fiji, Samoa, and Loo Choo Islands.	Shallow.	Coral reefs.	(4)
F. monilis (Val.), Perrier	Amboina; New Guinea (*fide* Studer).	...	.....	(5)
F. tumida, Bell	Ceylon; Andaman Islands.	...	.....	(6)
Ferdina, Gray.				
F. cancellata, Grube, sp.	Fiji Islands (Muss. Copenhagen and Berlin).	...	.....	(7)
F. cumingii, Gray	W. coast of Columbia.	...	.....	(8)
F. flavescens, Gray	Mauritius.	...	.....	(9)
F. kühlii, Müller and Troschel, sp.	Java.	...	.....	(10)
Ophidiaster, Agassiz.				
O. agassizii, Perrier	Juan Fernandez.	...	.....	(11)
O. arenatus (Lamarck), Perrier	?	?	?	(12)
×*O. attenuatus*, Gray	Mediterranean; Azores.	450	Volcanic mud.	(13)
O. bicolor (Lamarck), Perrier	?	?	?	(14)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	...	...	...	...	...	...	+	L	...	...	...	.....
(2)	...	...	+	...	...	...	...	L	...	...	...	.....
(3)	...	...	...	...	...	+	...	L	...	...	...	.....
(4)	...	...	+	...	+	+	+	L	...	...	...	= *Asterias milleporella*, Lamarck; *Linckia milleporella*, Müller and Troschel; *Scytaster milleporellus*, Michelin; *Linckia* (*Scytaster*) *milleporella*, von Martens. Incl.: *Scytaster pistorius*, Müller and Troschel; *Linckia pistoria*, von Martens.
(5)	...	...	...	...	+	...	...	L	...	...	...	= *Scytaster monilis*, Valenciennes, M.S.; *Scytaster milleporellus* (*pars*), Müller and Troschel; *Linckia milleporella* (*pars*), von Martens; *Scytaster crucellatis*, Grube (M.S. ?).
(6)	...	...	+	...	...	...	...	L	...	...	...	.....
(7)	...	...	...	...	...	...	+	L	...	...	...	= *Scytaster cancellatus*, Grube.
(8)	...	...	...	...	...	+	...	L	...	...	...	.....
(9)	...	...	+	...	...	...	...	L	...	...	...	.....
(10)	...	...	...	...	+	...	...	L	...	...	...	= *Scytaster Kühlii*, Müller and Troschel
(11)	...	...	...	...	...	...	+	L	...	...	...	.....
(12)	...	...	...	...	...	...	...	?	...	...	...	= *Asterias arenata*, Lamarck.
(13)	+	...	...	...	...	...	...	...	C	...	...	= *Ophidiaster* (*Hacelia*) *attenuatus*, Gray. Incl. *Asterias coriacea*, Grube.
(14)	...	...	...	...	...	...	...	?	...	...	...	= *Asterias bicolor*, Lamarck.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA. *Linckiidæ.* Linckiinæ. *Ophidiaster*, Agassiz.				
O. chinensis, Perrier	Canton (China).	...	.....	(1)
O. cribrarius, Lütken	Tonga Islands; Samoa.	...	.....	(2)
×*O. cylindricus* (Lamarck), Müller and Troschel	Mauritius; Moluccas, Fiji Islands.	Shallow.	Coral reefs.	(3)
O. duncani, de Loriol	Mauritius.	...	.....	(4)
O. floridæ, Perrier	Strait of Florida.	20	.....	(5)
O. fuscus (Gray), Perrier	Migupou (*fide* Gray), Philippine Islands (Brit. Mus.); N.W. Australia (*fide* Studer).	...	.....	(6)
O. germani, Perrier	New Caledonia.	...	.....	(7)
O. gracilis (Gray), Perrier	W. coast of Columbia.	...	.....	(8)
O. granifer, Lütken	Tonga Islands.	...	.....	(9)
O. guildingii, Gray	St. Thomas (Antilles).	...	.....	(10)
**O. helicostichus*, Sladen	Torres Strait.	6	Coral mud.	(11)
O. hemprichii, Müller and Troschel	Red Sea.	...	.....	(12)
O. lessonæ, Gasco	Capri; Mediterranean.	82	.....	(13)
×*O. ophidianus* (Lamarck), Agassiz	Mediterranean; Azores; Canary Islands; Cape Verde Islands.	5–450	Volcanic mud.	(14)
O. perrieri, de Loriol	Mauritius.	...	.....	(15)
O. purpureus, Perrier	Mauritius; Seychelles.	...	.....	(16)
O. pusillus, Müller and Troschel	Flores; Amboina; Philippine Islands; New Caledonia.	...	.....	(17)
O. pustulatus (von Martens), Perrier	Amboina; Flores; Mauritius (*fide* Studer).	...	.....	(18)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	...	...	...	...	+	...	L	...	...	....	.....
(2)	...	...	...	...	...	...	+	L	...	...	...	.....
(3)	...	...	+	...	+	...	+	L	...	...	...	= *Asterias cylindrica* (*pars*), Lamarck; *Dactylosaster cylindricus*, Gray; *Linckia cylindrica*, von Martens. Incl.: *Ophidiaster asperulus*, Lütken.
(4)	...	...	+	...	...	...	...	L	...	...	...	.....
(5)	+	...	...	...	...	...	...	L	...	...	...	.....
(6)	...	...	+	...	+	...	...	L	...	...	...	= *Tamaria fusca*, Gray.
(7)	...	...	...	...	...	...	+	L	...	...	....	.....
(8)	...	...	...	...	...	+	...	L	...	...	...	= *Dactylosaster gracilis*, Gray.
(9)	...	...	...	...	...	...	+	L	...	...	...	.....
(10)	+	...	...	...	...	...	...	L	...	...	...	Incl.: *Scytaster Müllerii*, Duchassaing (*fide* Perrier); *Ophidiaster flaccidus*, Lütken.
(11)	...	...	...	...	+	...	...	L	...	...	...	.....
(12)	...	...	+	...	...	...	...	L	...	...	...	.....
(13)	+	...	...	...	...	...	...	L	...	...	...	.....
(14)	+	...	...	...	...	...	...	...	C	...	...	= *Asterias ophidiana*, Lamarck. Incl.: *Ophidiaster aurantius*, Gray; (?) *Ophidiaster canariensis*, Greeff; *Asterias lævigata*, Drouet.
(15)	...	...	+	...	...	...	...	L	...	...	...	.....
(16)	...	...	+	...	...	...	...	L	...	...	...	= *Asterias cylindrica* (*pars*), Lamarck.
(17)	...	...	...	...	+	...	+	L	...	...	...	.....
(18)	...	...	+	...	+	...	...	L	...	...	...	= *Linckia pustulata*, von Martens.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA.				
Linckiidæ.				
Linckiinæ.				
Ophidiaster, Agassiz.				
O. robillardi, de Loriol . .	Mauritius.	...	.....	(1)
**O. tuberifer*, Sladen . . .	Torres Strait.	8	Coral mud.	(2)
Pharia, Gray.				
P. pyramidata, Gray . .	Margarita Bay; Cape St. Lucas; W. coast of Columbia.	...	.....	(3)
Leiaster, Peters.				
L. coriaceus, Peters . . .	Querimba Island; Mauritius.	...	.....	(4)
L. glaber, Peters . . .	Querimba Island.	...	.....	(5)
L. leachii (Gray), sp. . . .	Mauritius.	...	.....	(6)
×*L. speciosus*, von Martens . .	Off Flores; Fiji Islands.	...	.....	(7)
L. teres, Verrill, sp. . . .	La Paz (California).	...	.....	(8)
Linckia, Nardo.				
L. bouvieri, Perrier . .	Cape Verde Islands; Saō Thomé; Rolas.	10	.....	(9)
L. columbiæ, Gray . . .	W. coast of Columbia.	...	.....	(10)
L. ehrenbergii (Müller and Troschel), Perrier . .	Red Sea; Mozambique.	...	.....	(11)
L. erythræa, Gray . . .	Red Sea.	...	.....	(12)
L. franciscus, Nardo . . .	?	?	?	(13)
×*L. guildingii*, Gray . .	Cape Verde Islands; Bermuda; Antilles; Abrolhos reefs; Vera Cruz; Bahia.	...	.....	(14)
L. intermedia, Gray . . .	?	?	?	(15)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	...	...	+	...	...	...	...	L	...	...	...	.....
(2)	...	...	...	...	+	...	...	L	...	...	...	.....
(3)	...	...	...	...	...	+	...	L	...	...	...	= *Ophidiaster* (*Pharia*) *pyramidatus*, Gray. Incl.: *Ophidiaster porosissimus*, Lütken.
(4)	...	...	+	...	...	...	...	L	...	...	...	= *Ophidiaster Leachii* (*pars*), Perrier.
(5)	...	...	+	...	...	...	...	L	...	...	...	.....
(6)	...	...	+	...	...	...	...	L	...	...	...	= *Ophidiaster Leachii*, Gray.
(7)	...	...	...	...	+	...	+	L	...	...	...	.....
(8)	...	...	...	...	...	+	...	L	...	...	...	= *Lepidaster teres*, Verrill.
(9)	+	...	...	...	...	...	...	L	...	...	...	.....
(10)	...	...	...	...	...	+	...	L	...	...	...	.....
(11)	...	...	+	...	...	...	...	L	...	...	...	= *Ophidiaster Ehrenbergii*, Müller and Troschel.
(12)	...	...	+	...	...	...	...	L	...	...	...	= *Linckia* (*Acalia*) *erythræa*, Gray.
(13)	...	...	...	...	...	...	...	L	...	...	...	.....
(14)	+	+	...	...	...	...	...	L	...	...	...	Incl.: *Ophidiaster ornithopus*, Müller and Troschel; *Scytaster stella*, Duchassaing; *Linckia ornithopus*, Verrill.
(15)	...	...	...	...	...	...	...	L	...	...	...	= *Linckia* (*Acalia*) *intermedia*, Gray.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA. *Linckiidæ.* Linckiinæ.				
Linckia, Nardo.				
L. marmorata (Michelin), von Martens . . .	Mauritius; Prince of Wales Channel; Port Molle; Fitzroy Island (*fide* Bell).	7	.....	(1)
L. megaloplax, Bell . .	Port Curtis; Fitzroy Island; Albany Isld.; Port Denison.	8–12	.....	(2)
×*L. miliaris* (Linck), von Martens	Red Sea: Mozambique; Mauritius; Zanzibar; Ceylon; Madras; Andaman Islands; Flores; Timor; Celebes; Batjan; Philippine Islands; N. Australia; Claremont Isld.; New Caledonia; Caroline, Fiji, and Samoa Islds.	Shallow.	Coral reefs.	(3)
L. multifora (Lamarck), von Martens . . .	Red Sea; Mozambique; Mauritius; Ceylon; Larentuka; Celebes; Amboina; New Caledonia; Fiji, Samoa, and Sandwich Islands.	...	.....	(4)
L. nodosa, Perrier . .	Tortugas; Arafura Sea; Torres Strait (*fide* Bell).	6–36	.....	(5)
L. pacifica, Gray . . .	Mauritius; Nicobar Islands; Andaman Islands; Samoa Islands; Tahiti.	...	.....	(6)
×*L. pacifica*, var. *diplax* (Müller and Troschel) . .	Mauritius; Madagascar; Isle of Bourbon; Christmas Island; New Caledonia; Fiji and Tonga Islands; California (??).	Shallow.	Coral reefs.	(7)
L. pulchella, Gray . . .	?	?	?	(8)
L. rosenbergi, von Martens .	Amboina.	...	.....	(9)
Phataria, Gray.				
P. unifascialis, Gray . .	Margarita Bay; Cape St. Lucas; Acapulco; Pearl Islands; Panama; W. coast of Columbia; Zorritos (Peru); Timor (*fide* von Martens).	Shallow.	Rocks.	(10)
P. unifascialis, var. *bifascialis*, (Gray), Verrill . .	From California to Peru.	...	.....	(11)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0-150 Fathoms.	Continental, 150-500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	...	+	...	+	...	+	L	...	...	...	= *Ophidiaster marmorata*, Michelin.
(2)	...	...	...	...	...	...	+	L	...	...	...	.....
(3)	...	...	+	...	+	+	+	L	...	...	...	= *Pentadactylosaster miliaris*, Linck; *Ophidiaster miliaris*, Müller and Troschel. Incl.: *Asterias lævigata* (*pars*), Linné; *Linckia typus*, Nardo; *Ophidiaster lævigata*, Müller and Troschel; *Linckia Brownii*, Gray; *Linckia crassa*, Gray; *Ophidiaster clathrata*, Grube; *Linckia lævigata*, Lütken.
(4)	...	...	+	...	+	+	+	L	...	...	...	= *Asterias multifora*, Lamarck; *Ophidiaster multiforis*, Müller and Troschel; *Linckia multiforis*, von Martens. Incl.: *Linckia typus*, Gray; *Linckia Leachii*, Gray.
(5)	+	...	...	...	+	...	...	L	...	...	...	.....
(6)	...	...	+	...	...	...	+	...	...	...	...	= *Asterias lævigata* (*pars*), Lamarck.
(7)	...	...	+	...	...	?	+	...	...	...	...	= *Linckia pacifica* (*pars*), Gray; *Ophidiaster diplax*, Müller and Troschel; *Linckia diplax*, Perrier. Incl.: *Linckia nicobarica*, Lütken; (?) *Ophidiaster irregularis*, Perrier.
(8)	...	...	...	...	...	...	...	L	...	...	...	= *Linckia* (*Acalia*) *pulchella*, Gray.
(9)	...	...	...	...	+	...	...	L	...	...	...	.....
(10)	...	...	...	...	...	+	+	L	...	...	...	= *Linckia* (*Phataria*) *unifascialis*, Gray; *Ophidiaster* (*Linckia*) *unifascialis*, Lütken; *Linckia unifascialis*, Verrill. Incl.: *Ophidiaster suturalis*, Müller and Troschel; *Linckia suturalis*, von Martens.
(11)	...	...	...	...	...	+	+	L	...	...	...	= *Linckia* (*Phataria*) *bifascialis*, Gray; *Linckia unifascialis*, var. *bifascialis*, Verrill; *Linckia unifascialis* (*pars*), Perrier.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA. *Linckiidæ.* Linckiinæ.				
Nardoa, Gray, *emend.*				
N. ægyptiaca, Gray, sp.	Red Sea; Mauritius; Bourbon; (?) Nicobar Islands (*fide* Lütken); Samoa and Fiji Islds.; Sandwich Islds.	...	.....	(1)
N. galatheæ, Lütken, sp.	Nicobar Islands; Togean Island.	...	.....	(2)
N. gomophia, Perrier, sp.	New Caledonia.	...	.....	(3)
N. novæ-caledoniæ, Perrier, sp.	New Caledonia; Port Essington (*fide* Döderlein); Ceylon; Andaman Islands.	...	.....	(4)
N. obtusa, Perrier, sp.	Philippine Islands.	...	.....	(5)
N. pauciforis, von Martens, sp.	Adenare Island, near Flores; Bird Island (N.E. Australia).	...	.....	(6)
N. semiregularis, Müller and Troschel, sp.	Java.	...	.....	(7)
N. semiregularis, var. *japonica*, von Martens	Yokohama (Japan).	...	.....	(8)
N. semiseriata, von Martens, sp.	S. China.	40	.....	(9)
×*N. tuberculata*, Gray	Philippine Islands.	10	Coral reefs.	(10)
N. variolata (Linck), Gray	Red Sea; Mauritius; Mozambique; Rodriguez; Ceylon; Australia.	...	.....	(11)
Narcissia, Gray.				
×*N. canariensis*, d'Orbigny, sp.	Canary Islands; Cape Verde Islands.	...	.....	(12)
**N. trigonaria*, Sladen	Off Bahia (Brazil).	...	.....	(13)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	...	...	+	...	...	+	+	L	...	...	...	= *Gomophia ægyptiaca*, Gray; *Linckia ægyptiaca*, von Martens. Incl.: *Scytaster zodiacalis*, Müller and Troschel; *Oreaster Desjardinsii*, Michelin; *Scytaster Desjardinsii*, Lütken.
(2)	...	...	+	...	+	...	...	L	...	...	...	= *Scytaster galatheæ*, Lütken.
(3)	...	...	...	...	...	...	+	L	...	...	...	= *Scytaster gomophia*, Perrier.
(4)	...	...	+	...	+	...	+	L	...	...	...	= *Scytaster Novæ-Caledoniæ*, Perrier.
(5)	...	...	...	...	+	...	...	L	...	...	...	= *Scytaster obtusus*, Perrier.
(6)	...	...	...	...	+	...	+	L	...	...	...	= *Linckia pauciforis*, von Martens.
(7)	...	...	...	...	+	...	...	L	...	...	...	= *Scytaster semiregularis*, Müller and Troschel.
(8)	...	...	...	...	...	+	...	L	...	...	...	= *Linckia semiregularis*, var. *japonica*, von Martens.
(9)	...	...	...	...	...	+	...	L	...	...	...	= *Linckia semiseriata*, von Martens.
(10)	...	...	...	...	+	...	...	L	...	...	...	= *Ophidiaster tuberculatus*, Müller and Troschel; *Scytaster tuberculatus*, Lütken; *Linckia tuberculata*, von Martens.
(11)	...	...	+	...	...	...	...	L	...	...	...	= *Pentadactylosaster variolatus*, Linck; *Asterias variolata*, Retzius; *Linckia variolosa*, Nardo; *Scytaster variolatus*, Müller and Troschel; *Linckia variolata*, von Martens. Incl.: *Nardoa Agassizii*, Gray.
(12)	+	...	...	...	...	...	...	L	...	...	...	= *Asterias canariensis*, d'Orbigny. Incl.: *Narcissia Teneriffæ*, Gray; *Scytaster canariensis*, Dujardin and Hupé.
(13)	...	+	...	...	...	...	...	L	...	...	...	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA.				
Linckiidæ.				
Subfamily Metrodirinæ, Sladen.				
Metrodira, Gray.				
M. subtilis, Lütken, sp. . .	China Sea.	...	.....	(1)
×*M. subulata*, Gray . .	Torres Strait; Migupou (*fide* Gray); N. E. Australia; George Sound, New Zealand.	8	Coral mud.	(2)
Family *Zoroasteridæ*, Sladen.				
Zoroaster, Wyville Thomson.				
Z. ackleyi, Perrier . . .	Montserrat; Santa Cruz.	120–248	Coarse sand and broken shells.	(3)
Z. diomedeæ, Verrill . . .	E. coast of North America.	38–1555	Globigerina ooze.	(4)
×*Z. fulgens*, Wyville Thomson	Faeröe Channel; E. coast of North America; coast of Morocco and the Sahara; off Pernambuco.	500–1350	Blue mud; red mud.	(5)
Z. longicauda, Perrier .	Azores; Senegal; coast of the Sahara.	1637–2326	.....	(6)
Z. sigsbeei, Perrier . . .	St. Kitts; 28°42′ N., 88°40′ W.	208–321	Fine sand.	(7)
**Z. tenuis*, Sladen . . .	N. coast of New Guinea.	1070	Blue mud.	(8)
Cnemidaster, Sladen.				
**C. wyvillii*, Sladen . . .	Arafura Sea.	800	Green mud.	(9)
Pholidaster, Sladen.				
**P. distinctus*, Sladen . . .	Banda Sea.	140	Blue mud.	(10)
**P. squamatus*, Sladen . .	Off the Philippine Islands.	100	Green mud.	(11)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	...	...	...	...	...	+	...	L	...	...	...	= *Scytaster subtilis*, Lütken; *Fromia* (*Metrodira*) *subtilis*, Perrier.
(2)	...	...	...	...	+	...	+	L	...	...	...	*Scytaster subulatus*, Müller and Troschel; *Fromia* (*Metrodira*) *subulata*, Perrier.
(3)	+	...	...	...	...	...	...	L	C	...	...	.....
(4)	+	...	...	...	...	...	...	L	C	A	...	.....
(5)	+	+	...	...	...	...	...	...	...	A	38°·0–45°·7	.....
(6)	+	...	...	...	...	...	...	...	...	A	...	.....
(7)	+	...	...	...	...	...	...	...	C	...	...	.....
(8)	...	...	...	...	...	...	+	...	...	A	36°·4	.....
(9)	...	...	...	...	+	...	...	...	...	A	39°·5	.....
(10)	...	...	...	...	+	...	...	L	...	...	...	....
(11)	...	...	...	...	+	...	...	L	...	...	...	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA. Family *Stichasteridæ*, Perrier.				
Stichaster, Müller and Troschel.				
×*S. albulus* (Stimpson), Verrill	Greenland; northern coasts of America; Iceland; Spitzbergen.	3–192	Rocks and Hard ground	(1)
S. arcticus, Danielssen and Koren	Off the Lofoten Islands.	...	.....	(2)
×*S. aurantiacus* (Meyen), Verrill .	Peru; Chili.	Shallow.	Rocks.	(3)
S. australis (Verrill), Perrier .	Auckland (New Zealand).	...	.....	(4)
**S. felipes*, Sladen . . .	Off the Cape of Good Hope.	150	Green sand.	(5)
S. nutrix, Studer . . .	Island of South Georgia.	...	.....	(6)
**S. polygrammus*, Sladen . .	W. coast of South America.	245	Blue mud.	(7)
×*S. polyplax*, Müller and Troschel, sp. . . .	S. and S.E. Australia; Tasmania.	38–40	Sand and shells.	(8)
S. roseus (O. F. Müller), Sars .	Coasts of Britain and Norway.	2–50	Sandy clay.	(9)
S. talismani, Perrier . . .	Canary Islands; Azores.	517–782	.....	(10)
Neomorphaster, Sladen.				
**N. eustichus*, Sladen . . .	Off the Azores.	900–1000	Pteropod ooze.	(11)
Tarsaster, Sladen.				
**T. stoichodes*, Sladen . . .	N. of Admiralty Island.	150	Coral mud.	(12)
Family *Solasteridæ*, Perrier. Subfamily Solasterinæ, Sladen.				
Crossaster, Müller and Troschel.				
C. affinis, Brandt, sp. .	Between Norway, Spitzbergen, and Greenland; (?) Bering Strait.	70–634	Clay (coarse, sandy, Blue); stones.	(13)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	+	...	...	...	...	...	...	L	C	...	35°·5	= *Asteracanthion roseus* (*pars*), Müller and Troschel; *Asteracanthion albulus*, Stimpson; *Asterias albula*, Stimpson; *Stephanasterias albula*, Verrill. Incl.: *Asteracanthion problema*, Steenstrup; *Stichaster albulus*, var. *nitida*, Verrill.
(2)	+	...	...	...	...	...	...	...	?	...	...	.....
(3)	...	...	...	...	...	...	+	L	...	...	...	= *Asterias aurantiaca*, Meyen; *Asteracanthion aurantiacus*, Müller and Troschel. Incl.: *Stichaster striatus*, Müller and Troschel; *Tonia atlantica*, Gray.
(4)	...	...	...	...	...	...	+	L	...	...	...	= *Cœlasterias australis*, Verrill.
(5)	...	+	...	...	...	...	...	...	C	...	47°·0	.....
(6)	...	+	...	...	...	...	...	L	...	...	...	.....
(7)	...	...	...	...	...	...	+	...	C	...	46°·0	.....
(8)	...	...	...	...	...	...	+	L	...	...	...	= *Asteracanthion polyplax*, Müller and Troschel; *Asterias polyplax*, Perrier.
(9)	+	...	...	...	...	...	...	L	...	...	...	= *Asterias rosea*, O. F. Müller; *Linkia rosea*, Thompson; *Cribella rosea*, Forbes; *Asteracanthion roseus* (*pars*), Müller and Troschel.
(10)	+	...	...	...	...	...	...	...	...	A	...	.....
(11)	+	...	...	...	...	...	...	...	...	A	39°·4–40°·0	.....
(12)	...	...	...	...	...	...	+	L	...	...	...	....
(13)	+	...	...	...	...	?	...	L	C	A	29°·6–41°·1	= *Asterias affinis*, Brandt; *Solaster affinis*, Danielssen and Koren.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA.				
Solasteridæ.				
Solasterinæ.				
Crossaster, Müller and Troschel.				
(?) *C. alboverrucosus*, Brandt, sp.	Bering Strait.	...	.....	(1)
C. neptuni, Bell	Ecuador.	...	.....	(2)
×*C. papposus* (Linck), Müller and Troschel . . .	The whole northern area of the Atlantic extending to Discovery Bay; Assistance Bay; Newfoundland; Grand Manan; Massachusetts; Spitzbergen; Barents' Sea; Iceland; Nova Zembla; Murman coast; Scandinavian, British, and French coasts.	Shallow to 640	Hard ground; Clay.	(3)
C. papposus, var. *septentrionalis*, Sladen . . .	In the Faeröe Channel.	53–640	.....	(4)
**C. penicillatus*, Sladen .	Between Nightingale Island and Marion Island.	140	Volcanic mud.	(5)
Solaster, Forbes.				
S. abyssicola, Verrill . . .	E. coast of North America.	843–1537	.....	(6)
S. earllii, Verrill . . .	E. coast of North America.	...	.....	(7)
×*S. endeca* (Retzius), Forbes	Coasts of Greenland, North America, Norway, Britain, the Faeröe Islands, Iceland, Spitzbergen, and Murman coasts.	Shallow to 150.	Clay, stones, and sand.	(8)
S. endeca, var. *decemradiata*, Brandt	Sitcha.	...	.....	(9)
S. glacialis, Danielssen and Koren	Between Norway and Buren Island.	191	Sandy clay.	(10)
**S. paxillatus*, Sladen . . .	S. of Yeddo (Japan).	345	Green mud.	(11)
**S. regularis*, Sladen . . .	W. coast of Patagonia.	175	Blue mud.	(12)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	...	...	...	...	...	+	...	?	...	...	...	= *Asterias alboverrucosa*, Brandt.
(2)	...	...	...	...	...	...	+	?	...	...	...	.....
(3)	+	...	...	...	...	...	...	L	C	A	30°·0	= *Triskaidecactis papposus*, Linck; *Asterias papposa*, Fabricius; *Asterias* ("Solastéries") *papposus*, de Blainville; *Stellonia papposa*, Agassiz; *Solaster papposa*, Forbes; *Solaster* (*Polyaster*) *papposa*, Gray. Incl.: *Asterias helianthemoides*, Pennant.
(4)	+	...	...	...	...	...	...	L	C	A	30°·0–30°·5	.....
(5)	...	...	...	+	...	...	...	L	...	...	...	.....
(6)	+	...	...	...	...	...	...	...	...	A	...	= *Solaster Earllii* (*pars*), Verrill (*olim*).
(7)	+	...	...	...	...	...	...	...	...	A	...	.....
(8)	+	...	...	...	...	...	...	L	...	...	...	= *Asterias endeca*, Retzius; *Asterias* ("Solastéries") *endeca*, de Blainville; *Stellonia endeca*, Agassiz; *Solaster* (*Endeca*) *endeca*, Gray. Incl.: *Asterias aspera*, O. F. Müller.
(9)	...	...	...	...	...	+	...	?	...	...	...	= *Asterias endeca*, var. *decemradiata*, Brandt.
(10)	+	...	...	...	...	...	...	...	C	...	38°·3	.....
(11)	...	...	...	...	...	+	...	...	C	...	41°·1	.....
(12)	...	...	...	...	...	...	+	...	C	...	...	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA.				
Solasteridæ.				
Solasterinæ.				
Solaster, Forbes.				
**S. subarcuatus*, Sladen	Between Kerguelen and Heard Islands.	150	Coarse gravel.	(1)
**S. torulatus*, Sladen	N. of the Kermadec Islands.	520	Volcanic mud.	(2)
Lophaster, Verrill.				
L. furcifer (Düben and Koren), Verrill	Off the coasts of Greenland and North America; in the Gulf of Maine and off Nova Scotia; off the coasts of Norway, Spitzbergen, and Nova Zembla.	30–743	Clay and stones.	(3)
**L. stellans*, Sladen	W. coast of South America.	40–1325	Blue mud.	(4)
Rhipidaster, Sladen.				
**R. vannipes*, Sladen	Arafura Sea.	28	Green mud.	(5)
Subfamily Korethrasterinæ, Sladen.				
Korethraster, Wyville Thomson.				
K. hispidus, Wyville Thomson	In the Faeröe Channel; off coast of Norway and South of Franz-Josef Land.	101–632	Mud; Clay (coarse and sandy).	(6)
K. (?) *palmatus*, Perrier	Barbados.	76–200	Coarse sand and shells.	(7)
K. (?) *radians*, Perrier	Off Barbados and Havana.	56–80	Coral and broken shells.	(8)
K. (?) *setosus*, Perrier	"Travailleur" dredgings.	213–670	.....	(9)
Peribolaster, Sladen.				
**P. folliculatus*, Sladen	W. coast of Patagonia.	45	Green sand.	(10)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	...	...	...	+	...	...	...	L	...	...	35°·2	.....
(2)	...	...	...	...	...	...	+	...	...	A	43°·0	.....
(3)	+	...	...	...	...	...	...	L	C	A	29°·8–30°·5	= *Solaster furcifer*, Düben and Koren. Incl.: *Chætaster borealis*, Düben (*olim*).
(4)	...	...	...	...	...	...	+	L	C	A	36°·0–47°·0	.....
(5)	...	...	...	...	+	...	...	L	...	...	...	.....
(6)	+	...	...	...	...	...	...	L	C	A	30°·5	.....
(7)	+	...	...	...	...	...	...	L	C	...	64°·75	.....
(8)	+	...	...	...	...	...	...	L	...	...	74°·5	(?) = *Korethraster hispidus*, Perrier (*non* Wyville Thomson); (?) *Lophaster radians*, Perrier.
(9)	+	...	...	...	...	...	...	...	C	A	...	.....
(10)	...	...	...	...	...	...	+	L	...	...	...	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA.				
Solasteridæ.				
Solasteridæ *incertæ sedis:*				
Ctenaster, Perrier.				
C. spectabilis, Perrier	N. W. of Havana.	1920	.....	(1)
Radiaster, Perrier.				
R. elegans, Perrier	Off Dominica.	982	Fine brown mud.	(2)
Family *Pterasteridæ*, Perrier.				
Subfamily Pterasterinæ, Sladen.				
Pteraster, Müller and Troschel.				
×*P. affinis*, Smith	Off Kerguelen Island.	28	Volcanic mud.	(3)
P. aporus, Ludwig	Bering Sea.	...	.....	(4)
P. caribbæus, Perrier	Casco Bay; Sand Key; Nevis; Frederikstadt; St. Lucia.	151–451	Soft grey mud.	(5)
P. danæ, Verrill	E. coast of South America.	30 (?)	.....	(6)
×*P. militaris* (O. F. Müller), Müller and Troschel	Off the Norwegian, British, and North American coasts; off Spitzbergen and Nova Zembla; and in the Kara Sea.	10–530	Gravel, stones, sandy clay, or shelly ground.	(7)
P. militaris, var. *prolata*, Sladen	In the Faeröe Channel.	608	.....	(8)
P. pulvillus, Sars	Off the Norwegian and North American coasts; Nova Zembla; Murman coast.	50–2021	.....	(9)
**P. rugatus*, Sladen	Between Kerguelen and Heard Islands.	150	Coarse gravel.	(10)
**P. semireticulatus*, Sladen	Off Marion Island.	50	.....	(11)
P. sordidus, Perrier	"Talisman" dredgings.	622	.....	(12)
**P. stellifer*, Sladen	W. coast of South America.	245	Blue mud.	(13)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	+	...	...	...	...	...	...	...	...	A	39°·5	.....
(2)	+	...	...	...	...	...	...	...	...	A	39°·75	.....
(3)	...	...	...	+	...	...	...	L	...	...	...	.....
(4)	...	...	...	...	...	+	...	...	...	...	...	.....
(5)	+	...	...	...	...	...	...	...	C	...	...	.....
(6)	...	+	...	...	...	...	...	L	...	...	...	.....
(7)	+	...	...	...	...	...	...	L	C	A	35°·0–46°·2	= *Asterias militaris*, O. F. Müller; *Asteriscus militaris*, Müller and Troschel (*olim*).
(8)	+	...	...	...	...	...	...	...	...	A	30°·0	.....
(9)	+	...	...	...	...	...	...	L	C	A	...	.....
(10)	...	...	...	+	...	...	...	L	...	...	35°·2	.....
(11)	...	...	...	+	...	...	...	L	...	...	...	.....
(12)	+	...	...	...	...	...	...	...	...	A	...	Not yet described.
(13)	...	...	...	...	...	...	+	...	C	...	46°·0	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA.				
Pterasteridæ.				
Pterasterinæ.				
Retaster, Perrier.				
R. capensis, Gray, sp.	Cape of Good Hope.	...	.....	(1)
R. cribrosus, von Martens, sp.	Zanzibar; Mozambique; Ceylon; Philippine Islands.	...	.....	(2)
**R. gibber*, Sladen	W. coast of Patagonia.	245	Blue mud.	(3)
**R. insignis*, Sladen	Torres Strait; Banda Sea; Port Molle; Port Jackson (*fide* Bell).	6–25	Coral mud; Green mud.	(4)
R. multipes, Sars, sp.	Coasts of Norway and North America.	124–640	Greenish clay.	(5)
**R. peregrinator*, Sladen	Off Kerguelen Island.	127	Volcanic mud.	(6)
**R. verrucosus*, Sladen	Off Strait of Magellan (Atlantic side).	55	Sand.	(7)
Marsipaster, Sladen.				
M. alveolatus, Perrier	"Talisman" dredgings.	2192	.....	(8)
**M. hirsutus*, Sladen	Off Valparaiso.	2160	Blue mud.	(9)
**M. spinosissimus*, Sladen	33° 29′ 0″ S., 133° 22′ 0″ W.	2335	Red clay.	(10)
Calyptraster, Sladen.				
**C. coa*, Sladen	S.E. of Pernambuco.	350	Red mud.	(11)
Hymenaster, Wyville Thomson.				
**H. anomalus*, Sladen	N. of Tristan da Cunha.	1425	Pteropod ooze.	(12)
**H. cælatus*	S. of Australia.	1800	Globigerina ooze.	(13)
**H. carnosus*, Sladen	W, of South America.	1500	Globigerina ooze.	(14)
**H. coccinatus*, Sladen	Between Marion Island and the Crozet Islands.	1375	Globigerina ooze.	(15)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	...	+	...	...	...	...	...	?	...	....	...	= *Pteraster capensis*, Gray.
(2)	...	...	+	...	+	...	...	?	...	...	....	= *Pteraster cribrosus*, von Martens.
(3)	...	...	...	...	...	...	+	...	C	...	46°·0	.....
(4)	...	...	...	...	+	...	+	L	...	...	...	.....
(5)	+	...	...	...	...	...	...	L	C	A	...	= *Pteraster multipes*, Sars; *Diplopteraster multipes*, Verrill.
(6)	...	...	...	+	...	...	...	L	...	...	...	.....
(7)	...	+	...	...	...	...	...	L	...	...	47°·8	.....
(8)	+	...	...	...	...	...	...	...	...	A	...	Not yet described.
(9)	...	...	...	...	...	...	+	...	...	A	35°·2	.....
(10)	...	...	...	...	...	...	+	...	...	A	34°·8	.....
(11)	...	+	...	...	...	...	...	...	C	...	...	.....
(12)	...	+	...	...	...	...	...	...	...	A	37°·0	.....
(13)	...	...	...	+	...	...	...	...	...	A	33°·5	.....
(14)	...	...	...	...	...	...	+	...	...	A	35°·3	.....
(15)	...	...	...	+	...	...	...	...	...	A	36°·6	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA. *Pterasteridæ.* Pterasterinæ.				
Hymenaster, Wyville Thomson.				
**H. crucifer*, Sladen	S. of Australia.	1800	Globigerina ooze.	(1)
**H. echinulatus*, Sladen	33° 29′ 0″ S., 133° 22′ 0″ W.	2335	Red clay.	(2)
**H. formosus*, Sladen	S. of Australia.	1800	Globigerina ooze.	(3)
**H. geometricus*, Sladen	33° 29′ 0″ S., 133° 22′ 0″ W.	2335	Red clay.	(4)
H. giboryi, Perrier	"Talisman" dredgings.	2214	.....	(5)
**H. glaucus*, Sladen	S. of Japan.	565	Green mud.	(6)
**H. graniferus*, Sladen	Between Marion Island and the Crozet Islands.	1375	Globigerina ooze.	(7)
**H. infernalis*, Sladen	35° 22′ 0″ N., 169° 53′ 0″ E.	2900	Red clay.	(8)
**H. latebrosus*, Sladen	53° 55′ 0″ S., 108° 35′ 0″ E.	1950	Diatom ooze.	(9)
**H. membranaceus*, Wyville Thomson	S. W. of Cape Finisterre.	1125	Blue mud.	(10)
H. modestus, Verrill	E. coast of North America.	1098–1451	.....	(11)
**H. nobilis*, Wyville Thomson	S. of Australia.	1800	Globigerina ooze.	(12)
H. pellucidus, Wyville Thomson	In the Faeröe Channel; off the coast of Norway; and the Islands of Jan Mayen and Spitzbergen.	70–1539	Clay (various kinds).	(13)
**H. pergamentaceus*, Sladen	E. of Buenos Ayres.	2650	Blue mud.	(14)
**H. porosissimus*, Sladen	Off Valparaiso.	1375	Globigerina ooze.	(15)
**H. præcoquis*, Sladen	Between Marion Island and the Crozet Islands; off the Crozet Islands.	1375–1600	Globigerina ooze. Diatom ooze.	(16)
**H. pullatus*, Sladen	N. of New Guinea.	1070	Blue mud.	(17)
H. rex, Perrier	"Talisman" dredgings.	601–1093	.....	(18)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	...	...	+	...	...	...	...	...	A	33°·5	.....
(2)	...	...	...	...	...	...	+	...	...	A	34°·8	.....
(3)	...	...	...	+	...	...	...	...	...	A	33°·5	.....
(4)	...	...	...	...	...	...	+	...	...	A	34°·8	.....
(5)	+	...	...	...	...	...	...	...	...	A	...	Not yet described.
(6)	...	...	...	...	...	+	...	...	...	A	38°·1	.....
(7)	...	...	...	+	...	...	...	...	...	A	36°·6	.....
(8)	...	...	...	...	...	+	...	...	...	A	35°·3	.....
(9)	...	...	...	+	...	...	...	...	...	A	32°·1	.....
(10)	+	...	...	...	...	...	...	...	...	A	...	.....
(11)	+	...	...	...	...	...	...	...	...	A	...	.....
(12)	...	...	...	+	...	...	...	...	...	A	33°·5	.....
(13)	+	...	...	...	...	...	...	L	C	A	29°·6	.....
(14)	...	+	...	...	...	...	...	...	...	A	32°·7	.....
(15)	...	...	...	...	...	...	+	...	...	A	35°·5	.....
(16)	...	...	...	+	...	...	...	...	...	A	34°·2–36°·6	.....
(17)	...	...	...	...	...	...	+	...	...	A	36°·4	.....
(18)	+	...	...	...	...	...	...	...	...	A	...	Not yet described.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA.				
Pterasteridæ.				
Pterasterinæ.				
Hymenaster, Wyville Thomson.				
**H. sacculatus*, Perrier	South of Australia.	1800	Globigerina ooze.	(1)
**H. vicarius*, Sladen	Off Valparaiso.	1375	Globigerina ooze.	(2)
Benthaster, Sladen.				
**B. penicillatus*, Sladen	N. of New Guinea.	1070	Blue mud.	(3)
**B. wyville-thomsoni*, Sladen	35° 22′ 0″ N., 169° 53′ 0″ E.	2900	Red clay.	(4)
Myxaster, Perrier.				
M. sol, Perrier	"Talisman" dredgings.	?	?	(5)
Cryptaster, Perrier.				
C. personatus, Perrier	"Talisman" dredgings.	1637	?	(6)
Subfamily Pythonasterinæ, Sladen.				
Pythonaster, Sladen.				
**P. murrayi*, Sladen	E. of Buenos Ayres.	1900	Blue mud.	(7)
Family *Echinasteridæ*, Verrill, *emend.*				
Subfamily Acanthasterinæ, Sladen.				
Acanthaster, Gervais.				
×*A. echinites* (Ellis and Solander), Lütken.	Red Sea; Mauritius; Ceylon; Andaman Islands; Philippine Islands and Islands of the Eastern Archipelago; Fiji, Samoa, and Loo Choo Islands.	Shallow water.	Coral reefs.	(8)
A. ellisii (Gray)?	Galapagos Islands; coast of California; New Hanover; New Britain (*fide* Studer).	...	.....	(9)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	...	...	...	+	...	...	...	...	...	A	33°·5	.....
(2)	...	...	...	...	...	...	+	...	...	A	35°·5	.....
(3)	...	...	...	...	...	...	+	...	...	A	36°·4	.....
(4)	...	...	...	...	...	+	...	...	...	A	35°·3	.....
(5)	+	...	...	...	...	...	...	...	...	...	...	Not yet described.
(6)	+	...	...	...	...	...	...	...	...	A	...	Not yet described.
(7)	...	+	...	...	...	...	...	...	...	A	33°·1	.....
(8)	...	...	+	...	+	+	+	L	...	...	...	= *Asterias echinites*, Ellis and Solander; *Stellonia echinites*, Agassiz. Incl.: ? *Echinaster ellisii* (? *pars*), Gray; *Acanthaster echinus*, Gervais; *Echinaster solaris*, Müller and Troschel.
(9)	...	...	...	...	...	+	+	L	...	...	...	Incl.: *Acanthaster solaris*, Perrier.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA.				
Echinasteridæ.				
Acanthasterinæ.				
Acanthaster, Gervais.				
A. mauritiensis, de Loriol . .	Mauritius.	...	.....	(1)
A. solaris (Schreber), Dujardin and Hupé . . .	Strait of Magellan.	...	.....	(2)
Subfamily Mithrodiinæ, Viguier.				
Mithrodia, Gray.				
M. bradleyi, Verrill . . .	From California to Panama.	Shallow water.	Rocks.	(3)
×*M. clavigera* (Lamarck), Perrier	Mauritius; Java; Flores; Moluccas; Fiji Islands; Samoa Islands; Tahiti; Sandwich Islands.	Shallow water.	Coral reefs.	(4)
M. victoriæ, Bell . . .	Off E. coast of Brazil.	39	Dead coral.	(5)
Subfamily Echinasterinæ, Viguier.				
Cribrella (Agassiz), Forbes.				
C. antillarum, Perrier .	Barbados; Guadeloupe; Martinique; St. Lucia; off Buenos Ayres (*fide* Studer).	127–734	Hard; fine sand and mud.	(6)
**C. compacta*, Sladen . . .	Off New Zealand.	275	Globigerina ooze.	(7)
C. densispina, Sladen . .	Corean Strait.	40	.....	(8)
C. læviuscula, Stimpson .	Puget Sound; off coast of Oregon.	...	.....	(9)
C. minuta, Bell. . . .	Ecuador.	...	.....	(10)
**C. obesa*, Sladen . .	Falkland Islands; Strait of Magellan.	12–245	Sand, gravel; Blue mud.	(11)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0-150 Fathoms. L.	Continental, 150-500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	...	...	+	...	...	...	...	L	...	...	...	= *Acanthaster echinites*, Möbius (*fide* de Loriol).
(2)	...	...	...	...	...	...	+	L	...	...	...	= *Asterias solaris*, Schreber; *Echinaster solaris*, Gray.
(3)	...	...	...	...	...	+	...	L	...	...	...	.....
(4)	...	...	+	...	+	+	+	L	...	...	...	= *Asterias clavigera*, Lamarck. Incl.: *Mithrodia spinulosa*, Gray; *Ophidiaster echinulatus*, Müller and Troschel; *Heresaster papillosus*, Michelin; *Echinaster echinulatus*, von Martens; *Mithrodia echinulata*, Lütken.
(5)	...	+	...	...	...	...	...	L	...	...	...	.....
(6)	+	+	...	...	...	...	...	L	C	A	...	.....
(7)	...	...	...	...	...	...	+	...	C	...	50°·8	.....
(8)	...	...	...	...	...	+	...	L	...	...	...	.....
(9)	...	...	...	...	...	+	...	L	...	...	...	.....
(10)	...	...	...	...	...	...	+	L	...	...	...	.....
(11)	...	+	...	...	...	...	+	L	C	...	46°·0	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA. *Echinasteridæ.* Echinasterinæ.				
Cribrella (Agassiz), Forbes.				
×*C. oculata* (Linck), Forbes.	Off Scandinavian and British coasts; Greenland; Labrador; coast of N. America; Spitzbergen; Nova Zembla; in the White Sea; northern coast of Asia (*fide* Brandt).	Shallow water to 1350	Clay (sandy, Blue and Biloculina); Hard ground; Blue mud.	(1)
C. oculata, var. *abyssicola*, Norman	North Britain and Faeröe Channel.	516–555	.....	(2)
×*C. ornata*, Perrier . . .	Cape of Good Hope; New Zealand; Campbell Island.	Shallow to 20	.....	(3)
C. pagenstecheri, Studer . .	Island of South Georgia.	(?) less than 14	.....	(4)
**C. præstans*, Sladen . .	Between Marion Island and Kerguelen Island.	210	Hard ground (gravel, shells).	(5)
C. sexradiata, Perrier . .	Barbados; Gulf of Mexico.	101–321	Broken shells and corals.	(6)
**C. simplex*, Sladen . .	Inaccessible Island; Nightingale Island; Marion Island; Prince Edward Island; between Marion Island and Kerguelen.	50–310	Hard ground (gravel, shells); Volcanic sand.	(7)
**C. simplex*, var. *granulosa*, Sladen	Off Kerguelen Island.	10–50	Volcanic mud.	(8)
**C. sufflata*, Sladen . . .	S. of Kermadec Island.	520	Volcanic mud.	(9)
Perknaster, Sladen.				
**P. densus*, Sladen . . .	Off Kerguelen Island.	127	Volcanic mud.	(10)
**P. fuscus*, Sladen . .	Off Kerguelen Island; off Heard Island.	25–75	Volcanic mud.	(11)
Echinaster, Müller and Troschel.				
E. brasiliensis, Müller and Troschel	Coast of Brazil.	...	.....	(12)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	+	...	...	...	...	...	...	L	C	A	35°·0–47°·0	= *Pentadactylosaster oculatus*, Linck; *Asterias oculata*, Pennant; *Linkia oculata*, Forbes (*olim*); *Henricia oculata*, Gray; *Echinaster oculatus*, Müller and Troschel. Incl.: *Asterias sanguinolenta*, O. F. Müller; *Asterias pertusa*, O. F. Müller; *Asterias spongiosa*, Fabricius; *Asterias seposita*, Retzius; *Echinaster Eschrichtii*, Müller and Troschel; *Echinaster sanguinolentus*, Sars; *Echinaster Sarsii*, Müller and Troschel; *Linckia pertusa*, Stimpson; *Cribrella sanguinolenta*, Lütken; *Cribella Eschrichtii*, Dujardin and Hupé.
(2)	+	...	...	...	...	...	...	...	...	A	45°·5–46°·0	= *Cribrella oculata*, var. *cylindrella*, Sladen (*fide* Norman).
(3)	...	+	...	...	...	...	+	L	...	...	...	= *Echinaster* (*Cribella*) *ornatus*, Perrier (*olim*).
(4)	...	+	...	...	...	...	...	L	...	...	...	.....
(5)	...	...	...	+	...	...	...	...	C	...	...	.....
(6)	+	...	...	...	...	...	...	L	C	...	46°·75–61°·75	.....
(7)	...	+	...	+	...	...	...	L	C	...	...	.....
(8)	...	...	...	+	...	...	...	L	...	...	...	.....
(9)	...	...	...	...	...	...	+	...	...	A	43°·0	.....
(10)	...	...	...	+	...	...	...	L	...	...	...	.....
(11)	...	...	...	+	...	...	...	L	...	...	...	.....
(12)	...	+	...	...	...	...	...	L	...	...	...	= *Othilia multispina*, Gray; *Cribella brasiliensis*, Dujardin and Hupé; *Othilia brasiliensis*, Agassiz.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA.				
Echinasteridæ.				
Echinasterinæ.				
Echinaster, Müller and Troschel.				
E. crassus, Müller and Troschel	?	?	?	(1)
E. cribella, Lütken . . .	Valparaiso.	...	.....	(2)
E. deplanatus, Grube . .	?	?	?	(3)
×*E. eridanella* (Val., M.S.), Müller and Troschel . . .	New Caledonia; New Ireland; Admiralty Islands.	16–25	.....	(4)
E. gracilis, Müller and Troschel	Madagascar.	...	.....	(5)
E. lacunosus, Grube . . .	?	?	?	(6)
E. modestus, Perrier . .	Off Montsérrat; St. Vincent; N. of Havana; Guadeloupe.	101–309	Volcanic sand and mud.	(7)
E. purpureus (Gray), Bell .	Red Sea; Zanzibar; Querimba; Mauritius; Madras; Timor; Philippine Islands; Torres Strait; N.E. Australia; New Zealand (*fide* Perrier).	4–6	.....	(8)
E. rigidus, Grube . . .	?	?	?	(9)
E. scrobiculatus, Danielssen and Koren	Off coast of Finmark.	107	Stones and Clay.	(10)
E. sentus (Say), Lütken . .	Coast of Florida.	...	.....	(11)
E. sepositus (Lamarck), Müller and Troschel . . .	Mediterranean; off the coasts of Gascony and Brittany.	10–35	.....	(12)
E. serpentarius (Val., M.S.), Müller and Troschel .	Vera Cruz.	...	.....	(13)
×*E. spinosus* (Retzius), Müller and Troschel . . .	Virginia; Yucatan; Bahia; Rio Janeiro.	7–20	.....	(14)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	...	...	...	...	...	...	L	...	...	...	.....
(2)	...	...	...	...	...	...	+	L	...	...	...	.....
(3)	...	...	...	...	...	...	...	L	...	...	...	.....
(4)	...	...	...	...	...	...	+	L	...	...	...	Incl.: *Echinaster affinis*, Perrier.
(5)	...	...	+	...	...	...	...	L	...	...	...	Incl.: *Echinaster Clouei* (Val.), Perrier.
(6)	...	...	...	...	...	...	...	L	...	...	...	.....
(7)	+	...	...	...	...	...	...	L	C	...	46°·5–61°·75	.....
(8)	...	...	+	...	+	...	+	L	...	...	...	= *Othilia purpurea*, Gray. Incl.: *Echinaster fallax*, Müller and Troschel; *Cribella fallax*, Dujardin and Hupé; *Othilia luzonica*, Gray.
(9)	...	...	...	...	...	...	...	L	...	...	...	.....
(10)	+	...	...	...	...	...	...	L	...	...	41°·1	.....
(11)	+	...	...	...	...	...	...	L	...	...	...	= *Asterias sentus*, Say. Incl.: *Othilia aculeata*, Gray; *Echinaster spinosus* (*pars*), Müller and Troschel; *Othilia spinosa*, Agassiz.
(12)	+	...	...	...	...	...	...	L	...	...	...	= *Pentadactylosaster reticulatus brevis*, Linck; (?) *Asterias sepositа*, Lamarck; *Asterias* ("Pentastéries") *sepositа*, de Blainville; *Stellonia sepositа*, Nardo; *Rhopia sepositа*, Gray; *Rhopia mediterranea*, Gray; *Cribella sepositа*, Dujardin and Hupé. Incl.: *Asterias sanguinolenta*, Retzius; *Asterias sagena*, Retzius.
(13)	+	...	...	...	...	...	...	L	...	...	...	.....
(14)	+	+	...	...	...	...	...	L	...	...	...	= *Pentadactylosaster spinosus regularis*, Linck; *Asterias spinosa*, Retzius; *Othilia spinosa*, Gray. Incl.: *Asterias echinophora*, Lamarck; *Echinaster* (*Othilia*) *crassispina*, Verrill; *Echinaster crassispinus*, Lütken; *Echinaster echinophorus*, Perrier.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA.				
Echinasteridæ.				
Echinasterinæ.				
Echinaster, Müller and Troschel.				
×*E. spinulifer*, Smith . . .	Kerguelen.	28–127	Volcanic mud.	(1)
E. spinulosus, Verrill . .	Florida.	...	.....	(2)
E. tenuispinus, Verrill . .	La Paz.	...	.....	(3)
E. vestitus, Perrier	Mayotte Island.	...	.....	(4)
Plectaster, Sladen.				
P. decanus, Müller and Troschel, sp.	Port Jackson; Port Phillip; South-west Australia.	...	.....	(5)
Subfamily Valvasterinæ, Viguier.				
Valvaster, Perrier.				
V. striatus (Lamarck), Perrier .	Mauritius.	—	.....	(6)
Family *Heliasteridæ*, Viguier.				
Heliaster, Gray.				
H. canopus (Val., M.S.), Perrier.	Island of Juan Fernandez.	...	.....	(7)
H. cumingii (Gray), Verrill	Hood's Island; Chatham Island (Galapagos); Peru (*fide* Verrill).	...	.....	(8)
×*H. helianthus* (Lamarck), Dujardin and Hupé . .	Off Ecuador; Peru; Chili.	...	Rocks.	(9)
H. microbrachia, Xantus .	California; Mexico; Panama; Pearl Islands.	...	.....	(10)
H. multiradiata (Gray), Verrill	California; Mexico; Galapagos Islands; Sandwich Islands.	...	.....	(11)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	...	...	...	+	...	...	...	...	...	...	...	= *Othilia spinulifera*, Smith (*olim*).
(2)	+	...	...	...	...	...	...	L	...	...	...	.....
(3)	...	...	...	...	...	+	...	L	...	...	...	.....
(4)	...	...	+	...	...	...	...	L	...	...	...	= *Ophidiaster* (?) *vestitus*, Perrier (*olim*).
(5)	...	...	...	...	...	...	+	L	...	...	...	= *Echinaster decanus*, Müller and Troschel; *Solaster decanus*, Perrier.
(6)	...	...	+	...	...	...	...	L	...	...	...	= *Asterias striata*, Lamarck; *Asteracanthion striatus*, Müller and Troschel.
(7)	...	...	...	...	...	...	+	L	...	...	...	.....
(8)	...	...	...	...	...	...	+	L	...	...	...	= *Asterias* (*Heliaster*) *Cumingii*, Gray.
(9)	...	...	...	...	...	...	+	L	...	...	...	= *Asterias helianthus*, Lamarck; *Stellonia helianthus*, Agassiz; *Asterias* (*Heliaster*) *helianthus*, Gray; *Asteracanthion helianthus*, Müller and Troschel.
(10)	...	...	...	...	...	+	...	L	...	...	...	.....
(11)	...	...	...	...	...	+	+	L	...	...	...	= *Asterias* (*Heliaster*) *multiradiata*, Gray. Incl.: *Heliaster Kubiniji*, Xantus.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA.				
Family *Pedicellasteridæ*, Perrier.				
Pedicellaster, Sars.				
**P. hypernotius*, Sladen . .	Off Marion Island.	140	Volcanic sand.	(1)
P. margaritaceus, Perrier . .	"Travailleur" dredgings.	670	.....	(2)
P. octoradiatus, Studer . .	Off Island of South Georgia.	14	.....	(3)
P. palæocrystallus, Sladen .	Discovery Bay; Cape Frazer; (?) Gulf of St. Lawrence (*fide* Verrill).	25–80	Hard bottom.	(4)
P. pourtalesi, Perrier . .	Off Grenada; St. Kitts.	127–250	Fine sand.	(5)
P. sarsii, Studer . . .	Island of South Georgia.	...	.....	(6)
×*P. scaber*, Smith . .	Off Kerguelen Island.	20–25	Volcanic mud.	(7)
P. sexradiatus, Perrier . .	"Travailleur" dredgings.	1730–1808	.....	(8)
P. typicus, Sars. . .	Off Norwegian and Murman coasts; Nova Zembla; Jan Mayen; Beeren Island; Gulf of St. Lawrence (*fide* Verrill.	50–620	Clay (sometimes sandy); stones.	(9)
Family *Asteriidæ*, Gray, *emend.*				
Asterias, Linné.				
(*Asterias* sensu stricto.)				
×*A. amurensis*, Lütken . .	Yokohama; Gulf of Tartary	5–25	.....	(10)
×*A. cunninghami*, Perrier .	W. of Patagonia; Strait of Magellan; Falkland Islds.	0–55	Sand, gravel, rock kelp.	(11)
**A. glomerata*, Sladen .	Off Strait of Magellan, Atlantic side; Falkland Islds.	12–55	Sand, gravel.	(12)
×*A. meridionalis*, Perrier .	Off Kerguelen and Heard Islands.	10–127	Volcanic mud.	(13)
×*A. perrieri*, Smith . . .	Off Kerguelen Island.	25–110	Volcanic mud.	(14)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	...	...	+	...	...	...	L	...	...	...	.....
(2)	+	...	...	...	...	...	...	...	...	A	...	.....
(3)	...	+	...	...	...	...	...	L	...	...	...	.....
(4)	+	...	...	...	...	...	...	L	...	...	...	= *Asteracanthion palæocrystallus*, Sladen (*olim*).
(5)	+	...	...	...	...	...	...	L	C	...	52°·5–56°·0	.....
(6)	...	+	...	...	...	...	...	L	...	...	...	.....
(7)	...	...	...	+	...	...	...	L	...	...	...	.....
(8)	+	...	...	...	...	...	...	...	...	A	...	.....
(9)	+	...	...	...	...	...	...	L	C	A	29°·4–36°·5	.....
(10)	...	...	...	...	...	+	...	L	...	...	...	.....
(11)	...	+	...	...	...	...	+	L	...	...	47°·8	.....
(12)	...	+	...	...	...	...	...	L	...	...	47°·8	.....
(13)	...	...	...	+	...	...	...	L	...	...	...	.....
(14)	...	...	...	+	...	...	...	L	...	...	...	Incl.: *Othilia sexradiata*, Studer.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA. *Asteriidæ.*				
Asterias, Linné. (*Asterias* sensu stricto.)				
A. rubens, Linné	The British Area.	0–53	.....	(1)
**A. torquata*, Sladen	Yokohama, Japan.	5–25	.....	(2)
**A. versicolor*, Sladen	Off coast of Japan.	8–50	Sand.	(3)
**A. vesiculosa*, Sladen	Arafura Sea.	800	Green mud.	(4)
Subgen. *Cosmasterias*, Sladen.				
×*A.* (*C.*) *sulcifera*, Perrier, sp.	Messier Channel; Tierra del Fuego; Strait of Magellan; off Buenos Ayres (*fide* Studer).	345	Blue mud.	(5)
**A.* (*C.*) *tomidata*, Sladen	Gulf of Peñas.	45	Green sand.	(6)
Subgen. *Smilasterias*, Sladen.				
**A.* (*S.*) *scalprifera*, Sladen	Off Marion and Heard Islands.	50–75	Volcanic mud.	(7)
**A.* (*S.*) *triremis*, Sladen	Between Kerguelen and Heard Islands.	150	Coarse gravel.	(8)
Subgen. *Hydrasterias*, Sladen.				
**A.* (*H.*) *ophidion*, Sladen.	South of Nova Scotia.	1250	Blue mud.	(9)
Subgen. *Leptasterias* (Verrill).				
×*A.* (*L.*) *compta*, Stimpson, sp.	Off coast of New Jersey and S. of Nova Scotia.	85	Gravel, stones.	(10)
A. (*L.*) *mülleri*, Sars, sp.	Finmark; coast of Norway; Faeröe Channel.	53–433	.....	(11)
Subgen. *Stolasterias*, Sladen.				
×*A.* (*S.*) *africana*, Müller and Troschel, sp.	Cape of Good Hope.	5–20	.....	(12)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	+	...	...	...	...	...	...	L	...	...	...	= *Stellonia rubens*, Nardo; *Uraster rubens*, Forbes; *Asteracanthion rubens*, Müller and Troschel. Incl.: *Asterias glacialis*, Pennant; *Asterias clathrata*, Pennant; *Asterias holsatica* (? *pars*), Retzius; *Asterias minuta*, Retzius.
(2)	...	...	...	...	...	+	...	L	...	...	...	.....
(3)	...	...	...	...	...	+	...	L	...	...	...	.....
(4)	...	...	...	...	+	...	...	...	...	A	39°·5	.....
(5)	...	+	...	...	...	...	+	...	C	...	46°·0	= *Asteracanthion sulcifer* (Val., M.S.), Perrier; *Asterias sulcifer*, Perrier.
(6)	...	...	...	...	...	...	+	L	...	...	...	.....
(7)	...	...		+	..	...	...	L	...	...	...	.....
(8)	...	...	...	+	...	...	...	L	...	...	35°·2	.....
(9)	+	...	...	...	...	...	...	...	...	A	38°·0	.....
(10)	+	...	...	...	...	...	...	L	...	...	35°·0	= *Asterias compta*, Stimpson; *Leptasterias compta*, Verrill.
(11)	+	...	...	...	...	...	...	L	C	...	41°·3–49°·1	= *Asteracanthion Mülleri*, Sars; *Asterias Mülleri*, Norman; *Leptasterias Mülleri*, Verrill.
(12)	...	+	...	...	...	...	...	L	...	...	...	= *Asteracanthion africanus*, Müller and Troschel; *Asterias africana*, Perrier.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA. *Asteriidæ.*				
Asterias, Linné. Subgen. *Stolasterias*, Sladen.				
×*A.* (*S.*) *calamaria*, Gray, sp.	Mauritius; S. and S.E. Australia; Tasmania; New Zealand.	0–38	.....	(1)
**A.* (*S.*) *eustyla*, Sladen	Off Nightingale Island (Tristan da Cunha group).	100–150	.....	(2)
×*A.* (*S.*) *gemmifera* (Val., M.S.), Perrier, sp.	Chili; Fiji Islands.	...	Coral reefs.	(3)
×*A.* (*S.*) *glacialis*, O. F. Müller, sp.	Finmark; Iceland; European coasts; Mediterranean; Azores; Canary Islands; Cape Verde Islands.	0–66	.....	(4)
**A.* (*S.*) *stichantha*, Sladen	S. of Japan.	345	Green mud.	(5)
×*A.* (*S.*) *tenuispina*, Lamarck, sp.	Mediterranean; Madeira; Azores; Canary Islands; Cape Verde Islands; Bermuda; Abrolhos reefs.	0–174	.....	(6)
**A.* (*S.*) *volsellata*, Sladen	Off Zebu (Philippine Islands).	95	.....	(7)
Asterias (not classified in subgenera).				
A. acervata, Stimpson	Bering Strait.	5–15	Clean gravelly bottom.	(8)
A. acutispina, Stimpson	Island of Ousima.	...	.....	(9)
A. æqualis, Stimpson	Monterey (California).	...	.....	(10)
A. alba, Bell	Sandy Point (Strait of Magellan).	7–10	Dead acorn shells.	(11)
A. angulosa, Perrier	Alligator reefs; Strait of Florida.	85–110	.....	(12)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	...	+	...	...	...	+	L	...	...	...	= *Asterias calamaria*, Gray; *Asteracanthion calamaria*, Müller and Troschel. Incl.: *Coscinasterias muricata*, Verrill; *Asteracanthion australis*, Perrier; *Asterias Jehennesii*, Perrier.
(2)	...	+	...	...	...	...	...	L	...	...	...	.....
(3)	...	...	...	...	...	...	+	L	...	...	...	= *Asteracanthion gemmifer* (Val., M.S.), Perrier; *Asterias gemmifer*, Perrier.
(4)	+	...	...	...	...	...	...	L	...	...	...	= *Asterias glacialis*, O. F. Müller; *Stellonia glacialis*, Nardo; *Uraster glacialis*, Forbes; *Asteracanthion glacialis*, Müller and Troschel. Incl.: *Asterias spinosa*, Pennant; *Astèrias angulosa*, O. F. Müller; *Asterias echinophora*, Delle Chiaje; *Stellonia angulosa*, Agassiz; *Stellonia webbiana*, d'Orbigny; *Asteracanthion webbianum*, Dujardin and Hupé; *Asterias madeirensis*, Stimpson; *Marthasterias foliacea*, Jullien.
(5)	...	...	...	...	...	+	...	...	C	...	...	.....
(6)	+	+	...	...	...	...	...	L	...	...	...	= *Asterias tenuispina*, Lamarck; *Asteracanthion tenuispinus*, Müller and Troschel. Incl.: *Astèrias Suvaresi*, Delle Chiaje; *Asterias glacialis*, Grube; *Echinaster Doriæ*, Filippi; *Echinaster tribulus*, Filippi; (?) *Asterias atlantica*, Verrill.
(7)	...	...	...	...	+	...	...	L	...	...	...	.....
(8)	...	...	...	...	...	+	...	L	...	...	...	.....
(9)	...	...	...	...	...	+	...	L	...	...	...	.....
(10)	...	...	...	...	...	+	...	L	...	...	...	.....
(11)	...	+	...	...	...	...	...	L	...	...	...	.....
(12)	+	...	...	...	...	...	...	L	...	...	...	= (non *Asterias angulosa*, O. F. Müller).

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA. *Asteriidæ.*				
Asterias, Linné (not classified).				
A. antarctica (Lütken), Perrier	Puntas Arenas (Strait of Magellan).	...	.....	(1)
A. atlantica, Verrill	Abrolhos reefs; Bermuda; Cuba (?).	...	.....	(2)
A. bellii, Studer	Off E. coast of Patagonia.	63	Sandy mud.	(3)
A. borbonica, Perrier	Island of Bourbon.	...	.....	(4)
A. brachiata, Perrier	Gulf of Georgia.	...	.....	(5)
A. brandti, Bell	Trinidad Channel (Strait of Magellan).	30	Mud.	(6)
A. brevispina, Stimpson	San Francisco.	...	.....	(7)
A. briareus, Verrill	Off Chesapeake Bay.	31–373	.....	(8)
A. camtschatica, Brandt	Off Kamtschatka.	...	.....	(9)
A. capensis, Perrier	Cape of Good Hope.	...	.....	(10)
A. capitata, Stimpson	San Diego (California).	...	.....	(11)
A. clavata (Philippi), Perrier	Chili.	...	.....	(12)
A. conferta, Stimpson	Puget Sound.	...	.....	(13)
A. contorta, Perrier	Barbados; St. Vincent; Montserrat; Grenada; Guadeloupe; Sand Key; Carriacou; Cuba.	11–860	Volcanic and coarse sand, polyps, broken shells and rocks.	(14)
A. cribraria, Stimpson	N. of Bering Strait.	20–30	Muddy bottom.	(15)
A. disticha (Brandt), Perrier	Kanin Peninsula; White Sea.	...	.....	(16)
A. epichlora, Brandt	Sitcha; Puget Sound; Mouth of Oregon.	...	.....	(17)
A. exquisita, de Loriol	Santa Cruz (California).	Deep water.	.....	(18)
A. fascicularis, Perrier	Guadeloupe.	309	Volcanic sand and mud.	(19)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	...	+	...	...	...	...	...	L	...	...	...	= *Asteracanthion antarcticus*, Lütken.
(2)	+	...	...	...	...	...	...	L	...	...	...	Perhaps same as *Asterias* (*Stolasterias*) *tenuispina*, Lamarck, sp.
(3)	...	+	...	...	...	...	...	L	...	...	...	.....
(4)	...	...	+	...	...	...	...	L	...	...	...	.....
(5)	+	...	...	...	...	...	...	L	...	...	...	.....
(6)	...	...	...	...	...	...	+	L	...	...	...	.....
(7)	...	...	...	...	...	+	...	L	...	...	...	.....
(8)	+	...	...	...	...	...	...	L	C	...	...	.....
(9)	...	...	...	...	...	+	...	L	...	...	...	.....
(10)	...	+	...	...	...	...	...	L	...	...	...	.....
(11)	...	...	...	...	...	+	...	L	...	...	...	.....
(12)	...	...	...	...	...	...	+	L	...	...	...	= *Asteracanthion clavatum*, Philippi.
(13)	...	...	...	...	...	+	...	L	...	...	...	.....
(14)	+	...	...	...	...	...	...	L	C	A	30°·5–69°·0	.....
(15)	...	...	...	...	...	+	...	L	...	...	...	.....
(16)	+	...	...	...	...	...	...	L	...	...	...	= *Asteracanthium distichum*, Brandt.
(17)	...	...	...	...	...	+	...	L	...	...	...	.....
(18)	...	...	...	...	...	+	...	...	...	?	...	.....
(19)	+	...	...	...	...	...	...	...	C	...	...	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA. *Asteriidæ.*				
Asterias, Linné (not classified).				
A. fissispina, Stimpson	Shoalwater Bay, Oregon.	...	.....	(1)
A. forbesi (Desor), Verrill	E. coast of North America, Maine to Gulf of Mexico.	0–20	.....	(2)
A. forreri, de Loriol	Santa Cruz (California).	...	.....	(3)
A. fragilis, Studer	East of New Zealand.	597	.....	(4)
A. fulgens (Philippi), Perrier	Chili.	...	.....	(5)
A. fulva (Philippi), Perrier	Puerto Montt (Chili).	...	.....	(6)
A. fungifera, Perrier	Australia.	...	.....	(7)
A. gelatinosa, Meyen	Chili; Bolivia.	...	.....	(8)
A. georgiana, Studer	Isle of South Georgia.	...	.....	(9)
A. germaini (Philippi), Perrier	Castro (Island of Chiloe).	...	.....	(10)
A. gracilis, Perrier	Barbados; St. Lucia; St. Vincent; Cuba; Guadeloupe; Grenada; Martinique.	20–635	Sand, broken shells, rocks.	(11)
A. grœnlandica (Lütken), Stimpson	Off Greenland, and extending northward to Discovery Bay; Assistance Bay; Labrador; Gulf of St. Lawrence; Grand Manan; Spitzbergen; and Nova Zembla.	0–80	Rocks.	(12)
A. gunneri, Danielssen and Koren	Advent Bay, Spitzbergen.	60	Dark shingly clay.	(13)
A. hartii, Rathbun	E. of Cape Negro (Brazil); E. of Uruguay (*fide* Studer).	24–62	Gravel.	(14)
A. hexactis, Stimpson	Puget Sound.	...	.....	(15)
A. hispida, Pennant	The British Area.	.....	.....	(16)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0–150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	..	...	...	...	+	...	L	...	...	...	.....
(2)	+	...	...	...	...	...	...	L	...	...	...	= *Asteracanthion Forbesii*, Desor. Incl: *Asteracanthion berylinus*, A. Agassiz; *Asterias arenicola*, Stimpson; *Asteracanthion novæboracensis* (Val.), Perrier.
(3)	...	...	...	...	...	+	...	...	...	?	...	.....
(4)	...	...	...	...	...	...	+	...	...	+	...	.....
(5)	...	...	...	...	...	...	+	L	...	...	...	= *Asteracanthion fulgens*, Philippi.
(6)	...	...	...	...	...	...	+	L	...	...	...	= *Asteracanthion fulvum*, Philippi.
(7)	...	...	?	...	...	...	?	L	...	...	...	.....
(8)	...	...	...	...	...	...	+	L	...	...	...	= *Asteracanthion gelatinosus*, Müller and Troschel. Incl.: *Asterias rustica*, Gray.
(9)	...	+	...	...	...	...	...	L	...	...	...	.....
(10)	...	...	...	...	...	...	+	L	...	...	...	= *Asteracanthion Germaini*, Philippi.
(11)	+	...	...	...	...	...	...	L	C	A	30°·5–74°·5	.....
(12)	+	...	...	...	...	...	...	L	...	...	...	= *Asteracanthion Mülleri*, Sars (?), var., Steenstrup; *Asteracanthion grönlandicus*, Lütken. Incl.: *Uraster violacea* (*pars*), Forbes (?); *Asterias Mülleri*, Stimpson.
(13)	+	...	...	...	...	...	...	L	...	...	33°·26	.....
(14)	...	+	...	...	...	...	...	L	...	...	...	.....
(15)	...	...	...	...	...	+	...	L	...	...	...	.....
(16)	+	...	...	...	...	...	...	L	...	...	...	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA. *Asteriidæ.*				
Asterias, Linné (not classified).				
A. hyperborea, Danielssen and Koren	Bear or Cherry Island.	35	Hard shelly bottom.	(1)
A. inermis, Bell	Ecuador.	...	.....	(2)
A. janthina, Brandt	Sitcha.	...	.....	(3)
A. japonica, Stimpson	Japan.	...	.....	(4)
A. katherinæ, Gray	Oregon.	...	.....	(5)
A. lacazii, Perrier, sp.	South Carolina.	...	.....	(6)
A. linckii, Müller and Troschel, sp.	N. coast of Scandinavia; between Beeren Island and Spitzbergen.	70–148	Clay and hard ground.	(7)
A. linearis, Perrier	Off Alligator Reefs (Florida).	85—110	.....	(8)
A. littoralis, Stimpson, sp.	East Port (Maine); Bay of Fundy, Gulf of St. Lawrence.	Half-tide to 50.	Rocks and fuci.	(9)
A. lurida (Philippi), Perrier	Castro (Island of Chiloe).	...	.....	(10)
A. lütkeni, Stimpson	Oregon; California.	...	.....	(11)
A. mexicana (Lütken), Perrier	Vera Cruz (Mexico).	...	.....	(12)
A. mitis (Philippi), Perrier	Chili.	...	.....	(13)
A. mollis, Hutton	New Zealand.	...	.....	(14)
A. nautarum, Bell	Ecuador.	...	.....	(15)
A. neglecta, Bell	Gregory Bay (Strait of Magellan).	...	.....	(16)
A. normani, Danielssen and Koren	N.W. of Beeren Island	180	Firm sandy clay.	(17)
A. nuda, Perrier	Port Lincoln, Torres Strait.	...	.....	(18)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0-150 Fathoms.	Continental, 150-500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	+	...	...	...	...	...	...	L	...	...	33°·98	.....
(2)	...	...	...	...	...	...	+	L	...	...	...	.... .
(3)	...	...	...	...	...	+	...	L	...	...	...	.....
(4)	...	...	...	...	...	+	...	L	...	...	...	.....
(5)	...	...	. .	...	...	+	...	L	...	...	...	= *Asteracanthion Katherinæ*, Müller and Troschel. Incl.: ? *Asterias gigantea*, Stimpson.
(6)	+	...	...	...	...	...	...	L	...	...	...	= *Asteracanthion Lacazii*, Perrier. Incl. *Echinaster echinura*, Valenciennes.
(7)	+	...	...	...	...	...	...	L	...	...	...	= *Asteracanthion Linckii*, Müller and Troschel. Incl.: *Asterias stellionura*, Perrier.
(8)	+	...	...	...	...	...	...	L	...	...	61°·75	.....
(9)	+	...	...	...	...	...	...	L	...	..	...	= *Asteracanthion littoralis*, Stimpson.
(10)	...	...	...	...	...	...	+	L	...	...	...	= *Asteracanthion luridum*, Philippi.
(11)	...	...	...	...	...	+	...	L	...	...	...	.....
(12)	+	...	...	...	...	...	...	L	...	...	...	= *Asteracanthion mexicanum*, Lütken
(13)	...	...	...	...	...	...	+	L	...	...	...	= *Asteracanthion mûlle*, Philippi.
(14)	...	...	...	..	...	...	+	L	...	...	...	.....
(15)	...	...	...	...	...	...	+	L	...	...	...	.....
(16)	...	...	...	...	...	...	+	L	...	...	...	.....
(17)	+	...	...	...	...	...	...	L	...	...	36°·5	.....
(18)	...	...	...	...	+	...	...	L	...	...	...	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA. *Asteriidæ.*				
Asterias, Linné (not classified).				
A. obtusispinosa, Bell .	Sandy Point (Strait of Magellan).	9–10	Sand.	(1)
A. ochotensis (Brandt), Perrier	Shantar and Achae Islands, Tugur Bay (Sea of Okhotsk).	...	.....	(2)
A. ochracea, Brandt . . .	Sitcha to San Francisco.	Low water.	.....	(3)
A. panopla, Stuxberg . .	Kara Sea; N. of Scandinavian coast; between Beeren Island and Spitzbergen; off Spitzbergen.	23–260	Clay, Blue clay, stones.	(4)
A. paucispina, Stimpson . .	Puget Sound.	Circumlittoral.	.....	(5)
A. pectinata, Brandt . . .	Kamtschatka.	...	.....	(6)
A. philippi, Bell . .	"South America" (Hasslar Expedition).	...	.....	(7)
A. polaris (Müller and Troschel), Verrill	Greenland; Labrador; Gulf of St. Lawrence.	0–57	Rock.	(8)
A. rarispina, Perrier . . .	Cape of Good Hope.	...	.....	(9)
A. richardi, Perrier . . .	Off Marseilles (Mediterranean).	294	.....	(10)
A. rodolphi, Perrier . . .	Kermadec Islands.	...	.....	(11)
A. rollestoni, Bell . . .	Japanese Seas.	...	.....	(12)
A. rugispina, Stimpson .	Tierra del Fuego; Port Famine, Strait of Magellan; off Buenos Ayres (*fide* Studer).	30	.....	(13)
A. rupicola, Verrill . . .	Kerguelen Island.	Beach.	Rocky.	(14)
A. scabra (Hutton), Perrier .	New Zealand.	...	.....	(15)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	...	+	...	...	...	...	...	L	...	...	...	.....
(2)	...	...	...	...	...	+	...	L	...	...	...	=*Asteracanthium ochotense*, Brandt.
(3)	...	...	...	...	...	+	...	L	...	...	...	Incl.: *Asteracanthion margaritifer*, Müller and Troschel; *Asterias margaritifera*, Bell.
(4)	+	...	...	...	...	...	...	L	C	...	29°·4–34°·8	.....
(5)	...	...	...	...	...	+	...	L	...	...	...	.....
(6)	...	...	...	...	...	+	...	L	...	...	...	.....
(7)	...	...	...	...	...	...	?	L	...	...	...	.....
(8)	+	...	...	...	...	...	...	L	...	...	...	=*Asteracanthion polaris*, Müller and Troschel. Incl.: *Asterias rubens*, Fabricius; *Asterias minuta*, Fabricius; ? *Asterias violacea*, Sabine; *Asteracanthion rubens* (*pars*), Dujardin and Hupé; *Asterias borealis*, Perrier; *Asterias Douglasi*, Perrier.
(9)	...	+	...	...	...	...	...	L	...	...	...	.....
(10)	+	...	...	...	...	...	...	...	C	...	...	.....
(11)	...	...	...	...	...	...	+	L	...	...	...	.....
(12)	...	...	...	...	...	+	...	L	...	...	...	.....
(13)	...	+	...	...	...	...	...	L	...	...	...	.....
(14)	...	...	...	+	...	...	...	L	...	...	...	.....
(15)	...	...	...	...	...	...	+	L	...	...	...	=*Margaraster* (?) *scaber*, Hutton.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA. *Asteriidæ.*				
Asterias, Linné (not classified).				
A. sertulifera, Xantus	Margarita Bay; Cape San Lucas.	...	.....	(1)
A. sinusoida, Perrier . . .	Hobart Town (Tasmania).	...	.....	(2)
A. spectabilis (Philippi), Perrier	Island of Chiloe.	...	.....	(3)
A. spirabilis, Bell . . .	Off Falkland Islands.	...	.....	(4)
A. spitzbergensis, Danielssen and Koren	Spitzbergen.	37	Dark grey clay.	(5)
A. steineni, Studer . . .	Island of South Georgia.	...	.....	(6)
A. studeri, Bell . .	Off Kerguelen Island.	100	Black basaltic sand.	(7)
A. tanneri, Verrill . .	S. of Martha's Vineyard, and S. of Newport.	69–373	Sand and mud, shells and sponges.	(8)
A. tenera, Stimpson . .	S. of Cape Ann (Massachusetts Bay) to Bay of Fundy.	20	Rocky bottom.	(9)
A. troschelii, Stimpson . . .	Puget Sound.	...	.....	(10)
A. vancouveri, Perrier . .	Vancouver Island.	...	.....	(11)
A. varia (Philippi), Perrier .	Island of Chiloe.	...	.....	(12)
A. verrilli, Bell . . .	St. Martin's Cave; Pecket Harbour; Gregory Bay; Elizabeth Island.	...	.....	(13)
A. violacea, O. F. Müller . .	British Area; Finmark.	...	.....	(14)
A. vulgaris (Stimpson, M.S.), Packard . . .	Labrador to Cape Hatteras.	0–208	.....	(15)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic.	South Atlantic.	Indian Ocean.	Southern Ocean.	Eastern Archipelago.	North Pacific.	South Pacific.	Littoral, 0-150 Fathoms.	Continental, 150–500 Fathoms.	Abyssal, greater than 500 Fathoms.		
	I.	II.	III.	IV.	V.	VI.	VII.	L.	C.	A.		
(1)	...	...	...	...	...	+	...	L	...	...	...	.....
(2)	...	...	...	...	...	...	+	L	...	...	...	.....
(3)	...	...	...	...	...	...	+	L	...	...	...	= *Asteracanthion spectabile*, Philippi.
(4)	...	+	...	...	...	...	...	L	...	...	...	.....
(5)	+	...	...	...	...	...	...	L	...	...	31°·64	.....
(6)	...	+	...	...	...	...	...	L	...	...	...	.....
(7)	...	...	...	+	...	...	...	L	...	...	...	= *Asterias mollis*, Studer (*non* Hutton).
(8)	+	...	...	...	...	...	...	L	C	...	...	.....
(9)	+	...	...	...	...	...	...	L	...	...	...	= *Asterias* (*Leptasterias*) *tenera*, Verrill. Incl.: (?) *Asteracanthion flaccida*, A. Agassiz (*fide* Verrill).
(10)	...	...	...	...	...	+	...	L	...	...	...	.....
(11)	...	...	...	...	...	+	...	L	...	...	...	.....
(12)	...	...	...	...	...	...	+	L	...	...	...	= *Asteracanthion varium*, Philippi.
(13)	...	+	...	...	...	...	...	L	...	...	...	.....
(14)	+	...	...	...	...	...	...	L	...	...	...	= *Uraster violaceus*, Forbes; *Asteracanthion violaceus*, Müller and Troschel. Incl.: *Asterias holsatica*, Retzius; *Asterias minuta*, Retzius; *Asterias glacialis*, Johnston; *Stellonia rubens*, Forbes.
(15)	+	...	...	...	...	...	...	L	C	...	...	Incl.: *Asterias spinosa* (*pars*), Say; *Asterias rubens*, Gould; *Asteracanthion rubens*, Desor; *Asterias Fabricii* (A. Agassiz, M.S.), Perrier; *Asteracanthion pallidus*, A. Agassiz; *Asterias pallida*, Perrier; *Asterias* (*Leptasterias*) *Stimpsoni*, Verrill.

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA. *Asteriidæ.*				
Uniophora, Gray.				
U. globifera, Gray	Tasmania.	...	.....	(1)
U. granifera (Lamarck), Bell	Tasmania.	...	.....	(2)
Calvasterias, Perrier.				
C. antipodum, Bell	?	?	?	(3)
C. asterinoides, Perrier	Falkland Islands; Torres Strait (*fide* Perrier).	...	.....	(4)
**C. stolidota*, Sladen	Falkland Islands; Messier Channel (off W. coast of Chili).	5–10	.....	(5)
Anasterias, Perrier.				
A. minuta, Perrier	?	?	?	(6)
A. perrieri, Studer	Island of South Georgia.	?	?	(7)
Pycnopodia, Stimpson.				
P. helianthoides (Brandt), Stimpson	Sitcha; Puget Sound; Gulf of Singio; California.	?	.....	(8)
Asteriidæ *incertæ sedis:*				
Coronaster, Perrier.				
C. parfaiti, Perrier	Cape Verde Islands.	123	.....	(9)
Astrella, Perrier.				
A. simplex, Perrier	Mediterranean (coast of Morocco).	181	.....	(10)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0-150 Fathoms. L.	Continental, 150-500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	...	...	...	...	...	...	+	L	...	...	...	=*Asterias globifera*, Perrier.
(2)	...	...	...	...	...	...	+	L	...	...	...	=*Asterias granifera*, Lamarck; *Asteracanthion graniferus*, Müller and Troschel; *Margaraster graniferus*, Gray.
(3)	...	...	...	...	...	...	...	?	...	...	...	.....
(4)	...	+	...	...	+	...	...	L	...	...	...	.....
(5)	...	+	...	...	...	...	+	L	...	...	...	.....
(6)	...	...	...	...	...	...	...	?	...	...	...	Incl.: *Anasterias nuda*, Perrier.
(7)	...	+	...	...	...	...	...	?	...	...	...	.....
(8)	...	...	...	...	...	+	...	L	...	...	...	=*Asterias helianthoides*, Brandt.
(9)	+	...	...	...	...	...	...	L	...	...	...	.....
(10)	+	...	...	...	...	...	...	...	C	...	...	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA. Family *Brisingidæ*, Sars.				
Lubidiaster, Lütken.				
**L. annulatus*, Sladen	Off Kerguelen Island; Heard Island; Arafura Sea.	75–800	Volcanic mud; Green mud; coarse gravel.	(1)
×*L. radiosus* (Lovén M.S.), Lütken	E. coast of Patagonia; Strait of Magellan; Trinidad Channel.	30–63	Sand.	(2)
Odinia, Perrier.				
O. elegans, Perrier	Off the coast of Morocco.	482–784	.....	(3)
O. pandina, Sladen	In the Faeröe Channel.	440–500	.....	(4)
O. robusta, Perrier	Off the coast of Morocco.	482–784	.....	(5)
O. semicoronata, Perrier	Off the coast of Morocco.	577–784	.....	(6)
Brisinga, Asbjørnsen.				
**B. armillata*, Sladen	S. of Japan.	1875	Blue mud.	(7)
B. coronata, Sars	Lofoten Islands; W. coast of Norway; S. of Rockall; W. coast of Ireland; W. coast of Spain; Mediterranean (*fide* Perrier).	220–1366	Sandy clay.	(8)
B. costata, Verrill	E. of North America, between Cape Hatteras and Nova Scotia.	888–2021	.....	(9)
**B. cricophora*, Sladen	N.W. of St. Thomas, Virgin Islands.	390	Pteropod ooze.	(10)
**B. discincta*, Sladen	S. of Australia.	2600	Red clay.	(11)
B. endecacnemos, Asbjørnsen	W. coast of Norway; between the Faeröe and Shetland Islands; S.W. of Ireland; Bay of Biscay; W. of Ushant; off W. coast of Spain.	100–1095	.....	(12)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	...	...	...	+	+	...	...	L	C	A	35°·2–39°·5	.....
(2)	...	+	...	...	...	...	+	L	...	...	47°·8	Incl. : *Labidiaster luetkeni*, Bell.
(3)	+	...	...	...	...	...	...	...	C	A	...	=*Brisinga elegans*, Perrier (*olim*), *non* Verrill.
(4)	+	...	...	...	...	...	...	...	C	...	33°·9–41°·9	=*Brisinga coronata* (*pars*), Wyville Thomson.
(5)	+	...	...	...	...	...	...	...	C	A	...	=*Brisinga robusta*, Perrier (*olim*).
(6)	+	...	...	...	...	...	...	...	...	A	...	=*Brisinga semicoronata*, Perrier (*olim*).
(7)	...	...	...	...	...	+	...	...	...	A	35°·3	.....
(8)	+	...	...	...	...	...	...	...	...	...	43°·5–51°·8	.....
(9)	+	...	...	...	...	...	...	...	...	A	...	.....
(10)	+	...	...	...	...	...	...	...	C	...	...	.....
(11)	...	...	...	+	...	...	...	...	...	A	33°·9	.....
(12)	+	...	...	...	...	...	...	L	C	A	39°·7–51°·4	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA. *Brisingidæ.*				
Brisinga, Asbjørnsen.				
B. mediterranea, Perrier .	Between Marseilles and Corsica.	301–1454	.....	(1)
**B. membranacea*, Sladen .	Between Marion Island and the Crozet Islands; and W. of the Crozet Islands.	1375–1600	Globerina ooze; Diatom ooze.	(2)
**B. verticillata*, Sladen .	E. of North America; off the coast of New Jersey.	1350	Blue mud.	(3)
Freyella, Perrier.				
F. americana, Verrill, sp. . .	Off Nova Scotia.	175	.....	(4)
**F. attenuata*, Sladen . .	E. of the Mariana or Ladrone Islands.	2300	Radiolarian ooze.	(5)
**F. benthophila*, Sladen . .	39° 41′ 0″ S., 131° 23′ 0″ W.	2550	Red clay.	(6)
**F. bracteata*, Sladen . .	E. of North America; S. of Nova Scotia.	1250–1350	Blue mud.	(7)
**F. dimorpha*, Sladen . . .	Off Torres Strait, Pacific side.	1400	Globigerina ooze.	(8)
**F. echinata*, Sladen . .	Between Celebes and Mindanao; W. of the Island of Luzon; between the Pelew Islands and New Guinea.	1050–2150	Blue mud; Globigerina ooze.	(9)
F. edwardsi, Perrier . .	"Travailleur" dredgings. (? Mediterranean.)	...	.....	(10)
F. elegans, Verrill, sp. .	Between Cape Hatteras and Nova Scotia.	606–2021	.....	(11)
**F. fragilissima*, Sladen .	Between Marion Island and the Crozet Islands; near the Antarctic circle.	1375–1975	Globigerina ooze; Diatom ooze.	(12)
**F. heroina*, Sladen . .	Mid-north Pacific, 35° 22′ 0″ N., 169° 53′ 0″ E.	2900	Red clay.	(13)
**F. pennata*, Sladen . . .	S. of Japan.	1875	Blue mud.	(14)

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific. VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	+	...	...	...	...	...	...	...	C	A	...	.....
(2)	...	...	...	+	...	...	...	...	...	A	34°·2–36°·6	.....
(3)	+	...	...	...	...	...	...	...	...	A	37°·2	.....
(4)	+	...	...	...	...	...	...	...	C	...	...	= *Brisinga americana*, Verrill.
(5)	...	...	...	...	...	+	...	...	...	A	35°·5	.....
(6)	...	...	...	...	...	...	+	...	...	A	34°·8	.....
(7)	+	...	...	...	...	...	...	...	...	A	37°·2–38°·0	.....
(8)	...	...	...	...	...	...	+	...	...	A	36°·0	.....
(9)	...	...	...	...	+	+	...	...	...	A	35°·4–38°·9	.....
(10)	+	...	...	...	...	...	...	...	...	A	...	= *Brisinga Edwardsii*, Perrier (*olim*).
(11)	+	...	...	...	...	...	...	...	...	A	...	= *Brisinga elegans*, Verrill.
(12)	...	...	...	+	...	...	...	...	...	A	36°·6	.....
(13)	...	...	...	...	...	+	...	...	...	A	35°·3	.....
(14)	...	...	...	...	...	+	...	...	...	A	35°·3	.....

	Localities.	Range in Depth: Fathoms.	Nature of the Sea-Bottom.	
CRYPTOZONIA. *Brisingidæ.*				
Freyella, Perrier.				
**F. polycnema*, Sladen . .	N.E. of Kermadec Islands.	600	Hard ground.	(1)
**F. remex*, Sladen . . .	S.E. of New Guinea.	2440	Red clay.	(2)
F. sexradiata, Perrier . .	"Talisman" dredgings.	2733	.....	(3)
F. spinosa, Perrier . . .	Off coast of the Soudan.	784	.....	(4)
**F. tuberculata*, Sladen .	Between the Canary Islands and Cape Verde Islands; between coast of Africa and Island of Ascension.	2350–2400	Globigerina ooze.	(5)
Colpaster, Sladen.				
**C. scutigerula*, Sladen . .	S.W. of Canary Islands.	1525	Hard ground.	(6)
Genera of doubtful value:				
Brisingaster, de Loriol.				
B. robillardi, de Loriol . .	Mauritius.	60	.....	(7)
Hymenodiscus, Perrier.				
H. agassizii, Perrier . . .	Dominica; Santa Cruz.	391–450	Sand and Grey mud.	(8)
Gymnobrisinga, Studer.				
G. sarsii, Studer . .	N. or N.W. of Kerguelen Island.	115 or 150	.....	(9)

137 genera, 810 species, and 22 varieties are enumerated in this list.

	Geographical Areas.							Bathymetrical Zones.			Bottom Temperature: Fahrenheit.	Synonyma and Remarks.
	North Atlantic. I.	South Atlantic. II.	Indian Ocean. III.	Southern Ocean. IV.	Eastern Archipelago. V.	North Pacific. VI.	South Pacific VII.	Littoral, 0–150 Fathoms. L.	Continental, 150–500 Fathoms. C.	Abyssal, greater than 500 Fathoms. A.		
(1)	...	...	...	...	...	...	+	...	...	A	39°·5	.....
(2)	...	...	...	...	...	...	+	...	...	A	35°·8	.....
(3)	+	...	...	...	...	...	...	...	...	A	...	.....
(4)	+	...	...	...	...	...	...	...	...	A	...	.....
(5)	+	+	...	...	...	...	...	...	...	A	34°·0–36°·6	.....
(6)	+	...	...	...	...	...	...	...	...	A	37°·0	.....
(7)	...	...	+	...	...	...	...	L	...	...	...	.....
(8)	+	...	...	...	...	...	...	...	C	...	42°·5	.....
(9)	...	...	...	+	...	...	...	L	...	...	...	.....

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